THE 1990 TORONTO PERSONAL EXPOSURE PILOT (PEP) STUDY

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THE 1990 TORONTO PERSONAL EXPOSURE PILOT (PEP) STUDY
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Executive Summary

In a recent health survey sponsored by the Health Information Section of the City of Toronto, 60% of all respondents identified environmental air pollution as a major area of concern. In order to assess the total atmospheric concentration levels of volatile organic compounds (VOCs), some of which are toxic (such as benzene), to which people are exposed, a current air toxic VOC data base characterizing the major microenvironments in which individuals work and/or live must be established.

A Personal Exposure Pilot (PEP) study was designed to supply preliminary input to this much needed VOC data base with objectives of acquiring and analyzing indoor air samples from the office and home environments, ambient samples from the downtown and residential areas of Toronto, and samples as different staff members commuted to and from work and as they spent their noon-hours outdoors in the downtown area of Toronto.

Following an 8-day cycle from June to August, 65 field samples were collected and subsequently analyzed. Each sample was scanned for over 130 different VOCs but the number was reduced to 45 and finally to 22 of the more prevalent compounds in order to facilitate quality control, quality assurance, interpretation and presentation.

Large variations in VOC concentrations were noted in the indoor environments (office and home) and the indoor air quality appeared to be at least 2 to 5 times worse than the outdoor air quality.

With respect to the outdoor and commuting microenvironments, the poorest air quality was noted during the morning commutes and was thought to be due to the poorer atmospheric dispersion conditions, higher traffic density and cooler temperatures. The major source of ambient VOCs was deemed to be vehicular emissions.

In general, no unusual odours were detected during any of the sampling periods and all measured VOC concentrations were low.

Further work on personal exposure to toxic VOCs in Ontario urban areas, similar to the present study, is strongly recommended.

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1.0 INTRODUCTION / BACKGROUND:

In Report #3, entitled *Chemicals and Toxins*[1], prepared by the Community Health Information Section of the City of Toronto Department of Public Health, nearly 1000 individuals of age 15 years or older were interviewed in 1988 as part of a Toronto Community Health Survey. In this survey, questions were asked about health problems that may be environmentally influenced and other concerns with the Toronto environment in general. The survey findings reflected an increase in public awareness and concern regarding the environment with most respondents being dissatisfied with Toronto's environment. When respondents were asked to specify their concerns about the environment, 92% identified one or more areas. Air pollution with its associated problems were the most common (60% of the respondents), followed by water (44%) and chemical pollution (18%).

During 1989, a controversy arose regarding acceptable benzene concentration levels in the urban and rural environments. Following a worse case scenario, the Air Resources Branch conducted an ambient air study in the summer of 1989 in order to establish personal exposures to ambient benzene concentrations while refueling at retail gas stations and while walking in downtown Toronto. From analyses of the downtown samples, ambient benzene concentrations ranged from 3 to 24 $\mu g/m^3$ (micrograms per cubic metre) with a geometric mean of 9.8 $\mu g/m^3$ and from the refueling samples, the concentration range was 670 to 3640 $\mu g/m^3$ with a geometric mean of 2890 $\mu g/m^3$. (An internal ARB report was prepared for this study and excerpts are included in Appendic C.)

In late 1989, Toronto's Special Advisory Committee on the Environment released a report that proposed several initiatives to deal with the major environmental problems in the City of Toronto. The Environmental Protection Office (EPO) of the Department of Health was charged with conducting environmental assessments of atmospheric pollutants <u>not routinely monitored</u> by other regulatory agencies (for example, the Ministry of the Environment (MOE), Environment Canada (EC), etc.). The EPO retained the firm of Rowan, Williams, Davies and Irwin Inc. (RWDI) to undertake an assessment of air quality as it pertains to toxic compounds. Their air toxic study was to be composed of a historical review, an ambient air program and a risk assessment evaluation. The RWDI ambient program was conducted in March and June of 1990. Concurrent with this program, the Air Resources Branch (ARB) also undertook a limited monitoring program in the same general areas. ARB's program consisted of acquiring inhalation zone air samples (i.e. acquired at nose level) during the morning, noon and afternoon rush-hour

periods. The results of the ARB program were presented to the Central Region of MOE and the City of Toronto in two technical memoranda in the fall of 1990 and excerpts are also included in Appendix C.

Realizing that people living and working in the City of Toronto may spend as much as 90% of their time indoors and that commuting often constitutes a significant percentage of the person's time spent in the Toronto airshed (sometimes as much as 5 hours per day), an investigation into each of these microenvironments as well as outdoors air was needed if any toxicity assessment studies were to be carried out. (From analyses of data acquired in 44 different U.S. cities, W.R. Ott[2] reported that on the average, only 2% of an employed person's time was spent outdoors, 6% in-transit, 28% indoors at work and 63% indoors at home.)

A considerable amount of work had been done with respect to determining concentrations of the classical contaminants (such as sulphur dioxide, carbon monoxide, oxides of nitrogen, etc.) in these microenvironments but little has been done with respect to volatile organic compounds (VOCs). Therefore it was decided to conduct a pilot study in order to obtain a better understanding of personal exposure to this latter class of potentially toxic airborne pollutants.

The Personal Exposure Pilot (PEP) study's field objectives were to acquire indoor air samples for the office and home environments, outdoor ambient air samples for the downtown and residential areas of Toronto, and samples as different staff members commuted to and from work and as they spent their noon-hours outdoors in the downtown area of Toronto.

2.0 SURVEY METHOD AND RESULTS:

2.1 Method

The PEP field program started on June 11th and ran on an 8-day mid-week cycle (a Tuesday, Wednesday or Thursday) until August 29th.

The field samples were collected by pumping air, at a constant flow rate set in the range of 50 to 500 ml/min (millilitres per minute), through a three-layer cartridge containing adsorbents Carbotrap B, Carbotrap C and Spherocarb. Most volatile organics are trapped on these adsorbents whereas inorganics pass through. In total, 65 field samples were collected and analyzed for VOC content by the gas chromatograph flame ionization detector and mass selective detector (GC/FID/MSD) system at ARB. Each sample was thermally desorbed by heating the cartridge, under helium purge, to 300-350°C with the desorbed organic compounds being passed to and collected in a specially designed cryogenic loop. The collected

organics were then flash vaporized onto the head of a triple GC capillary column system held initially at -50°C (HP5880 system). The columns were 25 metre J&W fused silica 0.25mm ID (millimetre internal diameter) capillary columns with 1.0μm film thickness. Two of the columns (a DB-1 and a DB-5) were coupled to FIDs and the third (a matched DB-1 column) was coupled to the MSD system. Once the organics had been deposited at the head of these columns, a chromatographic temperature program was started. The component peaks eluting from the columns were identified and quantified using FID and MSD techniques. Each sample was scanned for over 130 different VOCs whose identity was based on retention indices stored in the GC/FID library. If an anomalous peak (unidentified VOC) appeared on the resulting chromatograms or if confirmation was needed, an MSD scan was performed on that particular peak. The MSD was a HP5970 unit with chemstation and associated analytical software. Throughout all of the analyses, no significant peaks apart from those registered in the system's library were identified. For both quantification and identification (with confirmation), the number of VOCs were further reduced to 45 of the more ubiquitous and prominent aliphatic and aromatic volatile organics and their halogenated (chlorinated) counterparts. A list of the respective method detection limits (MDLs) and method quantization limits (MQLs) and a table of the use(s) and source(s) of these 45 VOCs are given in Appendix A.

The major microenvironments investigated during this study were as follows:

- **Indoor:**

  Eight indoor office samples were obtained in several offices and one laboratory at the Air Resources Branch in downtown Toronto. The sampling was done while the normal occupant was out of the office and the sampler unit was usually placed atop the occupant's desk. The lab sample was exposed in ARB's main organic analytical laboratory while routine work was taking place. The monitoring was conducted between 9am to 4pm and all offices and the laboratory were "Smoke-Free Workplace Environments".

  Four indoor home samples were obtained at different residences within the Toronto airshed; namely, Oshawa, Thornhill, Scarborough and Richmond Hill. The sampling was conducted overnight with durations up to sixteen hours.

- **Outdoor:**

  Sixteen downtown ambient air samples were acquired near the entrance to the Metropolitan Police Centre at College and Yonge Streets and

7 residential ambient samples were collected in the backyard of #18 Garnock Avenue near Danforth and Broadview Avenue in Toronto. These two sites were only 4 to 5 km apart but the surroundings were quite different: the downtown site was characterized by a high traffic volume, asphalt, concrete and many high-rise buildings whereas the residential site was characterized by a much smaller traffic volume, some "Green" area(s) and low-rise buildings. Through the use of sequential sampler units, consecutive 12-hour samples were collected at each site and the air was sampled at a height of 1.5 metres above ground.

- **Commuting and Noon-Hours:**

  In order to simulate the typical commuter's exposure to VOCs, several staff members volunteered to participate in this phase of the study. They collected air samples while enroute to and from their residences and work and as they walked-about during the noon-hour periods in downtown Toronto. All participants were non-smokers and did not wear any lotions or perfumes during these periods.

  The air samples were collected by personal sampler units and the air was sampled within the inhalation zone of each participant. The samples were usually 1 to 2-hours in duration and 11, 8 and 8 VOC samples were collected during the morning, noon and afternoon periods respectively.

- **Special Samples:**

  While fulfilling the objectives set out in Section 1.0, four special composite samples were acquired during this study. The first 2 samples depicted indoor VOC concentrations while the participant was attending meetings; the 3rd was acquired while the participant was at a barbecue; and the 4th was an overall composite sample of the afternoon/morning commutes and the overnight residential indoor air quality (a 16-hour sample).

2.2 RESULTS:

(For a detailed listing of results, please see appendix B.)

2.2.0 Representative Chromatograms of the Different Programs Within PEP (Figures 1 and 2)

For a qualitative point-of-view, representative VOC fingerprint chromatograph profiles of each of the aforementioned microenvironments are presented for the

reader's information. Each peak in these chromatograms represents a response from a flame ionization detector to an organic compound as it eluted from a chromatographic column. The time of elution (retention time) indicates the identity of the organic and the area under each peak is directly proportional to its amount. This amount divided by the sampled air volume is equal to the organic's concentration in the air sampled.

These representative chromatograms are for qualitative comparisons only. As mentioned earlier, the ARB GC/FID library had the ability of identifying over 130 of these peaks and if some were considered to be significant, i.e. exhibit large areas, and were not contained in the library, an MSD scan was performed on the peak and its identity was resolved.

Each sample depicted in Figure 1 had been exposed for 8 hours and 36 litres of air were sampled. The top 2 chromatograms are representative of the outdoors environment (residential and downtown) and the bottom are representative of the indoor environments (office and home). These samples clearly show the air quality differences between the indoor and outdoor environments.

The samples shown in Figure 2 had been exposed for 1 to 2 hours with approximately 10 to 12 litres of air sampled. The first chromatogram is indicative of the morning commutes, the second indicative of the noon-hour walk-abouts and the last (bottom) chromatogram indicative of the afternoon commutes. As in the previous figure, these chromatograms clearly show different VOC profiles for each of these periods.

2.2.1 The Indoor Environments: Office and Home

As noted in Table 1, 8 VOC samples were obtained between June 20th and August 29th in 3 offices and the organic analytical laboratory at the Air Resources Branch. In general, all targeted VOC concentrations were low with levels ranging from less than the MDL (Appendix A) to approximately 80 $\mu g/m^3$. The more prominent VOCs were the low-boiling alkanes (propane to hexane; a maximum concentration of 32 $\mu g/m^3$), aromatics (benzene to xylenes; up to 63 $\mu g/m^3$) and chlorinated aliphatics (1,1-dichloroethene (20 $\mu g/m^3$), 1,1,1-trichloroethane (65 $\mu g/m^3$), tetrachloromethane (35 $\mu g/m^3$), trichloroethene (81 $\mu g/m^3$) and tetrachloroethene (35 $\mu g/m^3$)). Some high-boiler VOCs were also detected in these samples; namely, nonane (12 $\mu g/m^3$), 1,3,5-trimethylbenzene (20 $\mu g/m^3$), decane (35 $\mu g/m^3$), 1,3,5-trichlorobenzene (20 $\mu g/m^3$) and 1,2-dichlorobenzene (20 $\mu g/m^3$). *Bruce A. Tichenor et al.*[3] suggested that outgassing from chlorinated water was a major source of

trichloroethene and other chlorinated organics, and that perchloroethylene (tetrachloroethene) was emitted from dry-cleaned clothes. Major indoor sources of the higher ordered alkanes and aromatics are floor waxes, wood stains, furniture polishes, room fresheners and adhesives.

Upon first inspection of the indoor office VOC data set, a significant decrease in concentrations was noted in the four August samples as compared to the four June/July samples. When the monthly averages of the 22 short-listed VOCs (Table 2) are displayed (Figure 3), this abrupt change in air quality was more noticeable. From an elementary quantitative perspective, the total average concentration for the 22 VOCs detected in the June and July samples was 350 $\mu g/m^3$ whereas for the August samples, this average was only 50 $\mu g/m^3$. Many plausible reasons for this apparent improvement in air quality were investigated; for example: i) the building's air conditioner system had undergone extensive repair throughout the summer and ii) a nearby source of VOCs had been removed from the vicinity of the building's air conditioner intake manifolds (a nearby roofing operation). However after closer examination, neither of these two reasons were justified: chronologically, the air conditioner problems had been fixed by early July and the roofing operation had ended June 20[8]. Upon re-examining Table 1, the results obtained on July 13 were also similar to those reported for August. This observation suggested that the apparent improvement in air quality may be due to the inherent large variations in indoor measurements and the relatively small sample size of the present study. This hypothesis is also supported by B.A. Tichenor[2] as he stated, "(with respect to indoor measurements), the range of concentrations for a specific compound can vary widely between measurements" and that "In most studies, the concentrations of specific organic compounds exceed the outdoor concentrations, indicating that the major source of these compounds is indoors."

It was of interest to note that for the sample acquired in the analytical organic laboratory, the number and concentrations of VOCs measured were similar to those reported for the samples acquired in the offices. Two large fume hoods ensured 3 to 5 complete air exchanges per hour in this laboratory and emissions from the analytical work were being vented through these hoods effectively and efficently.

Four indoor air samples were acquired overnight at different staff members' homes. As noted in Table 3, apart from the expected low-boiling aliphatics that may be attributed to natural gas (heating) and other petroleum byproducts, higher ordered VOCs attributable to cleansers, detergents and solvents were detected. As with the office samples, some of the more prominent VOCs were dichloromethane (paint remover, cleaning solvent; 35 $\mu g/m^3$), 1,1,1-trichloroethane (a solvent/cleaner; 28 $\mu g/m^3$), toluene (solvent; 89 $\mu g/m^3$), xylenes (solvent; 39 $\mu g/m^3$), and

decane/nonane (detergents, floor waxes and room fresheners; 23 µg/m³).

It should be stated that all VOC concentrations measured in the aforementioned indoor samples were low and that no significant nor unusual odours were detected during any of the sampling periods.

2.2.2 The Outdoor Environments: Downtown & Residential

With respect to the ambient downtown VOC data (Table 4), the overall average VOC concentrations were low and similar to other concentrations that have been measured in the other urban airsheds (R. Bell[4], T. Dann[5] and J.J. Shah[6]). Apart from an obvious outlier toluene concentration of 520 µg/m³, average VOC concentrations measured in the outdoor downtown environment were all less than 20 µg/m³ and on the average, only 25 different VOCs were detected in each sample.

(With respect to toluene, the elevated concentration was detected during the daytime but no obvious source was apparent. Some localized activity may have taken place at this site as the more common sources of toluene are resins, adhesives, paints and coatings, dyes and perfumes. The Ministry Air Quality Standard for toluene is 2,000 µg/m³.)

Very low VOC concentrations were detected in the 7 ambient samples acquired at the residential site on Garnock Avenue (Table 5). As with the downtown site, all concentrations were less than 20 µg/m³ and on the average, only 20 different compounds were detected in the samples.

The samples acquired at both outdoor locations generally had similar profiles; that is, the dominant VOCs were the low-boiling alkanes (propane to hexane) and aromatics (benzene, toluene and xylenes) and there were only trace amounts of the chlorinated and substituted benzenes.

From a diurnal perspective, the ambient nighttime VOC concentrations measured at the dowtown site were slightly higher than those measured overnight at the residential site (Table 6 and Figures 4 and 5). These somewhat higher concentrations were thought to have resulted from the poorer overnight atmospheric dispersion conditions in the downtown area due to the high-rise buildings and the relatively larger traffic volume.

The average benzene, toluene and xylene concentrations normalized to ethylbenzene also lent some insight as to nature of the different sources in these areas. When comparing with the results of Tom Dann's[5] (1986) VOC sampling program conducted on Bredalbane Avenue in Toronto, a degree of similarity was noted.

	Downtown (College & Yonge)	Residential (Garnock)	T. Dann (Breadalbane)
Benzene/Ethylbenzene	2.1	2.0	2.5
Toluene/Ethylbenzene	5.7	6.5	10.0
Xylenes/Ethylbenzene	3.3	3.5	3.5

Breadalbane Avenue runs parallel to College Street and is approximately 0.3km to the north. Apart from the toluene/ethylbenzene ratio being somewhat higher in Dann's work (we also detected a large variability in the concentrations for this compound; a maximum of 520 $\mu g/m^3$ was detected but not included in the above table entries), the normalized ratios are similar and suggests that the major source(s) character in this area of Toronto has remained essentially unchanged throughout the past few years; namely, vehicular emissions.

Furthermore, T. Dann's work also supports the relatively low ambient concentrations of benzene detected during this study. As noted in Table 6, the average benzene concentrations ranged from 2 to 3.3 $\mu g/m^3$ and from T. Dann's work, a mean benzene concentration of 2.9 $\mu g/m^3$ was determined from the analyses of the 13 samples collected during August and October of 1986 at Breadalbane Avenue. (In addition, T. Dann also reported that between August 1984 and March 1986, the mean benzene concentration measured in 105 samples acquired at the Junction Triangle area of Toronto was 9.0 $\mu g/m^3$. Bell[4] also reported similar higher concentrations in the Junction Triangle during 1986.)

2.2.3 Outdoor Versus Indoor Air Quality

Upon comparing the indoor and outdoor VOC data sets acquired during the PEP study, the indoor air quality was highly variable yet appeared to be as much as 2 to 5 times worse than the outdoor air quality (Table 7 and Figure 6). The totals of the average short-listed 22 VOC concentrations for each of the four microenvironments were as follows: 43 $\mu g/m^3$ (outdoor, downtown), 32 $\mu g/m^3$ (outdoor, residential), 201 $\mu g/m^3$ (indoor, office) and 284 $\mu g/m^3$ (indoor, home).

Upon inspection of these data, the indoors appears to be a major source of chlorinated and higher-ordered aliphatics; namely 1,1,1-trichloroethane (dry cleaning), tetrachloromethane (floor waxes, furniture polishes, paints and adhesives), tetrachloroethene (dry cleaning, paint removers and solvents), nonane and decane (waxes, stains and room fresheners). These results are in keeping with the findings

of other workers (B.A. Tichenor (1988)[9] and H. Greim (1989)[8]) and have major implications as far as population exposure to toxic airborne substances is concerned. As mentioned earlier, Figure 7, taken from Ott[2] (1988), shows that on average, the portion of time spent indoors by employed people in 44 different U.S. cities was approximately 91%. One must therefore legitimately ask whether enough emphasis is being placed on indoor air quality studies as compared with the current ambient (outdoor) air monitoring programs.

2.2.4 The Commuting and Noon-Hour Programs

The Morning Rush-Hour:

Five ARB staff members participated in this phase of the PEP study in order to characterize personal exposures to toxic VOCs during the morning rush-hour periods. Each member employed different modes of transportation: apart from a short walk, EP and MS used their own cars for the entire commute (approximately 1 hour, 6 samples); BK used his car for approximately 20% of his commutes and the subway for the remainder (30 to 45 minutes, 2 samples); and RB and RC used their cars for approximately 15% of their commutes, the train for approximately 70% and walking or the subway for the remainder (1.5 hours, 3 samples).

Only 20 to 30 different VOCs were detected in each of the 11 morning rush-hour samples (Table 8). The low-boiling alkane concentrations ranged to 160 $\mu g/m^3$ (pentane), the aromatics to 160 $\mu g/m^3$ (toluene) and the chlorinated aliphatics to 310 $\mu g/m^3$ (chloromethane). No unusual odours were detected during any of the commutes.

From an empirical qualitative perspective, the cleanest commutes appeared to belong to RB and RC, followed by BK, EP and finally MS. The 100 and 310 $\mu g/m^3$ chloromethane concentrations detected in the 2 samples acquired by the commuters who used the train for a large percentage of their time may have been due to outgassing from solvents used in the trains, the upholstery, etc. or more likely, both people had to wait for the trains in a smoke-filled area (cigarette smoke is a major source of chloromethane). It appears that MS had a dirtier car (elevated concentrations of aliphatics and aromatics) than EP (although a similar type of VOC profile was obtained for EP's commute, the aliphatic and aromatic concentrations were somewhat lower whereas the chlorinated compound concentrations had increased).

The Afternoon Rush-Hour:

The same staff members participated in the afternoon program and once again, the data (Table 9) indicated that the participants who used their own cars (EP and MS) had the highest exposure to VOCs and the participants who used public transit (BK and RC) had the least. The overall VOC concentrations were much less than the morning rush-hour commutes and usually only 20 to 30 of the 45 targeted compounds were detected in the samples. Apart from the 2 elevated concentrations of 465 $\mu g/m^3$ (chloromethane; possibly cigarette smoke or dry cleaning) and 105 $\mu g/m^3$ (butane; possibly vehicular emissions), all concentrations were less than 50 $\mu g/m^3$.

Intercomparison of the Morning and Afternoon Commutes:

As noted in Table 11 and Figure 8, exposures to higher VOC concentrations occurred during the morning commutes. Not considering the afternoon outlier chloromethane concentration of 465 $\mu g/m^3$ and only considering the 22 short-listed VOCs, the total average concentrations for the afternoon and morning periods were approximately 1100 and 2800 $\mu g/m^3$ respectively. On this somewhat limited basis, these data suggest that the morning commuters were exposed to almost 3 times as much VOCs as the afternoon commuters.

It was thought that this disparity was due to better atmospheric dispersion conditions normally present in the afternoons and the more broad-banded or extended afternoon rush-hour period. In Toronto, the morning rush-hour usually extends from 6:30 to 8:30am whereas during the afternoons, the rush-hour runs from 4 to 7pm (2 versus 3 hours).

These observations are backed by similar assessments undertaken by several other researchers. For example, a recent paper by C.C. Chan and J.D. Spengler of the Harvard School of Medical Health (Boston)[9] contained the following observations:

1) Higher traffic densities and the lower atmospheric dispersion rates in urban street canyons are believed to be the main causes of measuring greater VOC exposure in urban airsheds.
2) Commuters had the highest VOC exposures driving private cars and the lowest exposures riding subways (in Boston).
2) No significant difference in in-vehicle VOC concentrations was found between new and old cars, and between domestic and imported cars.

From the data acquired during the commutes, the benzene, toluene and xylene concentrations normalized to ethylbenzene are as follows:

	Junction Triangle*	Afternoon	Morning
Benzene/ethylbenzene	2.8	2.6	4.7
Toluene/ethylbenzene	7.4	5.4	8.6
Xylenes/ethylbenzene	4.3	4.0	4.2

*T. Dann[4] analyses of 105 samples acquired at the Junction Triangle between August 1984 and March 1986.

From this analysis, the commuting aromatic profiles appear to be similar to the long-term air quality aromatic profile of the Junction Triangle area. Major sources of benzene are antiknock gasolines, rubber cements, solvents, paint removers, and fumigants; major sources of toluene are adhesive solvents, gasolines, resins, oils, and phenols; and major sources of xylenes are solvents, gasoline, protective coatings, lacquers and rubber cements. All are characteristic of vehicular emissions, in-vehicular environments and the solvent, paint and adhesive industries of the Junction Triangle.

The Noon-Hour Walk-Abouts:

During the PEP study, eight 1-hour VOC ambient air samples were collected by staff members as they walked-about in the downtown area of Toronto. The route taken was a figure-eight pattern around the outdoor sampler site (Section 2.2.2) at the College Street police station.

Upon examining the acquired VOC data (Table 10), very low concentrations were measured and only half of the 45 targeted compounds were detected. The maximum individual concentration was only 21 $\mu g/m^3$.

As a note of interest, 21 $\mu g/m^3$ of 1,2-dichlorobenzene was detected during week 6 of this study and a trace amount was also reported in the outdoor ambient samples acquired at the police station (Section 2.2.2, Table 4). The more common sources of this contaminant are metal polishes, fumigants and insecticides. It appears that the police kept the alcove area, where the outdoor sampler was located and where the noon-hour participants stopped to have a rest during their walk-abouts, very clean.

The 4 Special Samples: (Table 3)

- The 1st special sample was exposed for almost 2 hours at a barbecue. Although high VOC concentrations were expected, the measured concentrations were only indicative of background levels routinely detected in other urban airsheds of Ontario.

- The 2nd and 3rd samples were exposed during a meeting. The samples were of 1 hour or less and the measured concentrations were again very low. Although there had been a considerable amount of cigarette smoke present, the measured concentrations did not highlight this source (the maximum chloromethane, benzene and toluene concentrations were only 6.5, 6 and 14 $\mu g/m^3$ respectively).

- The 4th sample was a 16-hour sample acquired during commuting to and from work and overnight. Somewhat higher concentrations for the 45 selected VOCs were recorded but the relative contributions from major sources (i.e. the home, automobile and commuter train) could not be determined. The dominant VOCs measured in this sample were butane (59 $\mu g/m^3$), pentane (35 $\mu g/m^3$), toluene (73 $\mu g/m^3$) and xylenes (35 $\mu g/m^3$).

2.2.5 Comparisons with other Ministry Studies:

(For a detailed listing of the results from these studies, please see Appendix C.)

The MOE 1990 Toronto Toxics and Benzene Studies:

As mentioned in the Introduction and as noted in the introductory paragraphs of the two memoranda pertaining to the Spring and Summer Toronto Toxics studies conducted by ARB, these studies were run concurrent with another monitoring program undertaken by the firm of RWDI. RWDI was retained by the Environmental Protection Office of the City of Toronto to perform an environmental assessment of gaseous toxic compounds in the downtown core area of Toronto.

For ease of comparison, the average concentrations for the low-boiling alkanes and aromatics measured during the ARB Toronto Toxics and PEP studies are presented below. The Toronto Toxic samples were ambient samples collected along the busy traffic routes in downtown Toronto during the morning, noon and afternoon rush-hour periods. They were one-hour inhalation zone samples and staff members walked in figure eight patterns in the vicinity of the Royal Ontario Museum and Old City Hall.

Volatile Organic Compounds
(Average Concentrations)

	Toronto Toxics			PEP	
	Spring	Summer	Noon-Hour	Downtown	Residential
Number of samples	(17)	(12)	(8)	(16)	(7)
Propane	24	20	10	4	1
Chloromethane	4	<4	1	1	nd
Butane	20	11	5	5	6
Pentane	13	14	7	5	4
Benzene	12	10	4	3	2
Toluene	15*	22	9	8**	7
Tot. Xylenes	14	10	4	5	4
Ethylbenzene	3	3	2	1	1
Benz./Ethbenz.	4	3.3	2	3	2
Tolu./Ethbenz.	5.3	7.3	4.5	8	7
Xyls./Ethbenz.	4.7	3.3	2	5	4

Concentration units are $\mu g/m^3$
* Not including an outlier concentration of 221 $\mu g/m^3$
** Not including an outlier concentration of 520 $\mu g/m^3$

As additional references, gasoline vapour and liquid phase hydrocarbon compositions (M. Round[9]) and the average VOC concentrations acquired during the ARB 1989 Benzene Study are summarized below. For the Benzene study, the one-hour ambient samples were acquired along relatively busy streets in downtown Toronto and the retail gas station samples were acquired during refueling of private automobiles (inhalation zone samples with exposures of 1 to 3 minutes).

	Liquid (%)	Vapour (%)	V/L Phase Ratio	Benzene Study	
				Ambient	Retail St'n
Number of samples				(12)	(7)
Propane	0.1	5.2	52	30	5,000
Butane	6.2	41.1	6.6	23	108,500
Pentane	4.0	5.6	1.4	13	30,000
Benzene	2.1	0.9	0.43	9	4,300
Toluene	10.4	0.8	0.08	22	3,500
Xylenes	4.9	0.1	0.02	15	1,000
Ethylbenzene	1.2	0.4	0.33	4	250
Benzene/Ethylbenzene	1.8	2.2		2.3	17.2
Toluene/Ethylbenzene	8.7	2.0		5.5	14
Xylenes/Ethylbenzene	4.1	0.3		3.8	4

From the data set above, the following may be stated:

- The ambient walk-about samples of the Toronto Toxics and Benzene studies are almost identical (in both the way they were carried out and results). These samples were taken along the busy traffic arteries in downtown Toronto and the results infer that vehicles are a major source of VOCs in the area.
- The normalization ratios for benzene, toluene and xylenes to ethylbenzene for all ambient measurements (the PEP, Toronto Toxics and the Benzene studies) appear to be fairly consistent: the first ratio being between 2 and 4; the second being between 4.5 and 8 and; the third being between 2 and 5. As anticipated, these ratios are not similar to those reported by M. Round for pure gasoline vapour phase composition. It is generally accepted that although the vehicle is the major ubiquitous source of VOCs in urban airsheds, the specific source is not just gasoline vapour emissions but rather a composite of many point source emissions from the vehicle (for example, tailpipes, engine compartments, greases and oils, hot soaks, etc.). The chromatographic VOC profiles are slightly shifted towards the higher boilers, but the major VOCs were the same in all samples, namely; propane, butane and toluene which make up almost 50% of the vapour phase gasoline.
- The PEP ambient VOC concentration results appear to be only half of those reported for the other studies. The PEP samples were long-term (12-hour) general air quality samples as compared to the short-term (1 to 2 hours) high impact, source specific samples (i.e. rush-hour, gas stations, etc.) acquired during the other studies.
- It is generally accepted that the greatest personal exposure to VOCs occurs during refueling at gas stations. This point was very obvious from the data of the 1989 Benzene study and was also stressed at a gasoline exposure workshop planning group discussion[10] held in the fall of 1990 in Annapolis, Maryland. (The Exxon Company had conducted a similar study in 1983 to assess gasoline exposures during self-service refueling. From 134 samples, the total hydrocarbon average exposure was 21 ppm (parts per million) with an average exposure time of 2.4 minutes during refueling and an average of 10.5 gallons being pumped. Ubiquitious, background ambient total hydrocarbon concentrations normally range from 1.5 to 3 ppm.)

3.0 Conclusions:

The PEP study represents an initial step to assess, in a more comprehensive manner, the exposure of individuals in the Toronto area to various VOCs (some of which, such as benzene, are toxic). The VOC data set is very small and therefore the following conclusions are to be regarded as only tentative. As a result of these initial findings, the need for further work in this area is strongly recommended.

- In general, all measured VOCs were low and none of the applicable Ministry Air Quality Standards, Criteria or Guidelines were exceeded during this study.
- Analyses of all field samples acquired during this study indicated VOC profiles and concentrations similar to other work that the Ministry and other research groups have done within these same microenvironments in which people must work and live.
- Since people usually spend in excess of 90% of their time indoors, air quality of this microenvironment must be explored in greater detail if any personal exposure assessments are to be carried out.
- Highly variable indoor air quality was noted during this study and investigations as to causality have to be carefully planned. Minimal requirements would be concurrent indoor and adjacent outdoor air sampling programs ...something that was not followed during this study. From the PEP data set, the indoor air quality appeared to be as much as 2 to 5 times worse than the outdoor air quality.
- With respect to outdoor air quality, higher VOC concentrations were noted in the downtown area due to lower atmospheric dispersion rates and the higher traffic volumes. This was especially evident in samples collected overnight and during the morning rush-hour (commuting) periods.
- VOC concentrations measured during the morning commutes were almost 3 times higher than the afternoon commutes.
- Commuting in personal vehicles resulted in greater exposures to VOCs than commuting by public transport.

4.0 References:

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4. R.W. Bell et al.; *Comparison of Ambient Air Quality Surveys in the Junction Triangle Area and Downtown Metropolitan Toronto*; **Air Resources Branch Publication; ARB-099-85-ARSP**
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9. M. Round, N. Anderson, D. Brown et al.; *Evaluation of the Health Effects From Exposure to Gasoline and Gasoline Vapours;* **Final Report to NESCAUM (Northeast States for Coordinated Air Use Management) Air Toxics Committee, August 1989.**
10. ENVIRON Corporation; *Summary Report on Individual and Population Exposures to Gasoline ;* **Gasoline Exposure Workshop Planning Group, Exxon (unpublished data) pp 29, (1990).**

APPENDIX A
(The Lab Work)

Method Detection and Method Quantization Limits 21
The Shortened VOC Target List 22

Method Detection & Quantitation Levels (MDLs & MQLs) - July '90

For 12 litre samples

	MDL ug/m**3		MQL ug/m**3
1 Propane	0.3	< T <	1.3
2 Chloromethane	0.7	< T <	3.6
3 Chloroethene	0.5	< T <	2.3
4 1,3-Butadiene	0.9	< T <	4.7
5 Butane	0.4	< T <	1.8
6 Acrylonitrile	0.9	< T <	4.6
7 Pentane	0.4	< T <	2.1
8 Isoprene	0.9	< T <	4.7
9 1,1-Dichloroethene	0.4	< T <	2.1
10 Dichloromethane	1.3	< T <	6.3
11 Hexane	0.3	< T <	1.7
12 Trichloromethane	1.8	< T <	9.0
13 1,2-Dichloroethane	0.2	< T <	1.0
14 1,1,1-Trichloroethane	4.6	< T <	22.9
15 Benzene	0.3	< T <	1.5
16 Tetrachloromethane	5.1	< T <	25.6
17 Cyclohexane	0.3	< T <	1.3
18 1,2-Dichloropropane	0.4	< T <	1.9
19 Trichloroethene	1.3	< T <	6.4
20 Heptane	0.7	< T <	3.4
21 1,1,2-Trichloroethane	0.6	< T <	3.0
22 Toluene	0.6	< T <	3.0
23 1,2-Dibromoethane	1.6	< T <	8.0
24 Octane	0.5	< T <	2.4
25 Tetrachloroethene	1.4	< T <	7.1
26 Chlorobenzene	0.7	< T <	3.7
27 Ethylbenzene	0.3	< T <	1.6
28 m-Xylene	0.9	< T <	4.3
29 p-Xylene	0.4	< T <	2.0
total m,p-Xylenes	0.9	< T <	4.3
30 Styrene	1.0	< T <	4.8
31 1,1,2,2-Tetrachloroethane	1.5	< T <	7.4
32 o-Xylene	0.8	< T <	4.0
33 Nonane	1.0	< T <	4.9
34 1,3,5-Trimethylbenzene	0.3	< T <	1.2
35 1,2,4-Trimethylbenzene	0.7	< T <	3.4
36 1,3-Dichlorobenzene	1.1	< T <	5.6
37 Decane	1.8	< T <	9.0
38 1,4-Dichlorobenzene	0.3	< T <	1.7
39 1,2-Dichlorobenzene	1.4	< T <	6.9
40 1,2-Diethylbenzene	0.7	< T <	3.3
41 Undecane	1.5	< T <	7.3
42 1,2,4-Trichlorobenzene	0.6	< T <	2.9
43 Naphthalene **	0.0	< T <	0.0
44 Dodecane	1.0	< T <	5.1
45 Tridecane	0.7	< T <	3.6

** - no MDL nor MQL available for this compound

SHORTENED VOC TARGET LIST

	COMPOUND		USES	SOURCES
1	Propane	n-Propane	organic synthesis, fuel, manufacture of ethylene, refrigerant, solvent, refrigerant, gas enrichant, aerosol propellant	natural gas; petroleum marketing; vehicles
2	Chloromethane	(methyl chloride)	silicones; refrigerant;	pharmaceutical production; cigarette smoke; medicine; fluid for thermometric and thermostat equip low temperature solvent; propellant in high-pressure
3	Chloroethene	(vinyl chloride)	plastics manufacture; organic synthesis; cooling medium	ethylene dichloride products; PVC Products aerosols; herbicides
4	1,3-Butadiene	(vinylethylene)	in styrene-butadiene rubber; to a lesser degree in polybutadiene and nitrile elastomers;	waste oil combustion; in low yields; resins; organic intermediate
5	Butane	n-Butane	organic synthesis, synthetic rubber, high-octane liquid fuels, ethylene manufacturing, solvent, refrigerant, aerosol propellant, food additive	natural gas; petroleum marketing; vehicle emissions; plastic manufacturing
6	Acrylonitrile	(vinyl cyanide)	acrylic and modacrylic fibers and high strength whiskers; ABS and acrylonitrile-styrene copolymers; nitrile rubber, cyanoethylation of cotton; synthetic soil blocks, organic synthesis, grain fumigant	misc. solvent usage, ABS plastics
7	Pentane	n-Pentane	artificial ice manufacturing, solvent extraction, blowing agent in plastics	plastics; distillation from petroleum
8	Isoprene	(2-methyl-1,3-butadiene) (2-methyl-1,3-butadiene)	monomer for manufacture of polyisoprene; chemical intermediate, molecular unit of natural rubber	recovery from petroleum cracking streams; dimerization of propylene, trans
9	1,1-Dichloroethene	(vinylidene chloride)	copolymerized with vinyl chloride or acrylonitrile to form various kinds of saran and other copolymers and adhesives. a component of synthetic fibers	plastic wrap and adhesives
10	Dichloromethane	(methylene chloride)	paint remover; extraction & cleaning solvent; fumigant; blowing agent; refrigeration	waste oil combustion; solvent usage
11	Hexane	n-Hexane	extraction solvent for edible oil & fat; solvent; diluent; low-temp thermometer	misc. solvent usage; thermometers
12	Trichloromethane	(chloroform)	solvent and uses (plastics; floor polish; fluorocarbons; dyes; pesticides); crop, from pulp/paper bleaching wastewater; anaesthetics; pharmaceuticals	pharmaceutical production; waste oil combustion
13	1,2-Dichloroethane	(ethylene dichloride)	evaporation of leaded fuel; extraction & cleaning solvent;	petroleum marketing; pesticide application; waste oil
14	1,1,1-Trichloroethane	(methyl chloroform)	solvent for dry cleaning, precision instruments aerosol propellant, metal degreasing, pesticides	various solvent & cleaning applications
15	Benzene	(cyclohexatriene)	medicines & chemicals; dyes; insecticides; fumigants; paint removers; rubber cement; antiknock gasoline; synthetic detergents; solvent	petroleum marketing; vehicles; waste oil combustion; airport operations

16	Tetrachloromethane	(carbon tetrachloride)	solvent applications (oil, wax & fat extraction); rubber cement; shoe & furniture polish; paints & lacquers; stains; printing ink; floor varnish; Freon-11 and 12 production; misc. uses (pharmaceutical manufacture; pesticide formulation; chlorine prod.) stain removal.	pesticide application; misc. surface coating; misc. solvent usage
17	Cyclohexane	(hexamethylene)	manufacture of nylon; solvent for cellulose ethers; fats; oils; chemical; glass substitutes	manufacturing applications; misc. solvent usage nylon, paint and varnish removers
18	1,2-Dichloropropane	(propylene dichloride)	intermediate for perchloroethylene and carbon tetrachloride; lead scavenger for antiknock fluids; solvents for fats, oils, waxes, gums and resins; solvent mixtures for cellulose agents; metal degreasing agents; soil fumigant for nematodes	waste oil combustion; misc. solvent usage vehicular exhaust
19	Trichloroethene	(trichloroethylene)	metal degreasing; solvent & cleaning applications; PVC production; refrigerant & heat exchange liquid; organic synthesis; fumigant; medicines	waste oil combustion; misc. solvent usage
20	Heptane	n-Heptane	standard for octane rating determinations; solvent, anaesthetic, organic synthesis	petroleum marketing; vehicle emissions; anaesthetic
21	1,1,2-Trichloroethane	(vinyl trichloride)	solvent for fats, oils, waxes, resins; other products, organic synthesis	misc. solvent usage
22	Toluene	(methylbenzene)	explosives; dyes; benzene manufacture; solvent; solvent for pesticides & insecticides	petroleum marketing; vehicles; waste oil combustion; airport operations; solvent usage; misc. surface coating; asphalt distribution; pesticides & insecticides.
23	1,2-Dibromoethane	(ethylene dibromide)	scavenger for lead in gasoline; grain and fruit fumigant; general solvent; waterproofing preparations; organic synthesis; insecticide; medicine	misc. solvent and thinners usage vehicular exhaust
24	Octane	n-Octane	solvent, organic synthesis, azeotropic distillations	petroleum marketing; vehicle emissions
25	Tetrachloroethene	(perchloroethylene)	drycleaning solvent; textile processing & refinishing; metal cleaning & degreasing; chemical prod. intermediate; misc. solvent use (mag. tapes; plastics; rubber solutions; paint removers; inks; solvent soaps; fats; oils	dry cleaners; waste oil combustion; misc. solvent usage
26	Chlorobenzene	(phenyl chloride)	solvents for lacquers, paints, & waxes; intermediate for dyes, perfumes & pesticide manufacturing;	misc. solvent usage
27	Ethylbenzene	(phenylethane)	solvent; intermediate	petroleum marketing
28	m-Xylene	(1,3-dimethylbenzene)	intermediate for dyes & organic synthesis; solvent; insecticide; aviation fuel	airport operations; pesticide application; solvent usage
29	p-Xylene	(1,4-dimethylbenzene)	pharmaceutical synthesis; insecticides	pharmaceutical production; pesticide application
30	Styrene	(vinylbenzene)	manufacture of plastics, rubber, & resins; insulator	uncontrolled emissions from small industries
31	1,1,2,2-Tetrachloroethane	(acetylene tetrachloride)	extraction & cleaning solvent; insecticide; herbicide; paint remover; varnish & lacquer;	misc. solvent usage; pesticide application
32	o-Xylene	(1,2-Dimethylbenzene)	raw material for chemical intermediate (phthalic anhydride)	chemical production
33	Nonane	n-Nonane	organic synthesis, biodegradable detergents, distillation chaser	petroleum marketing; detergents
34	1,3,5-Trimethylbenzene	(mesitylene)	intermediate; including anthraquinone fat dyes; ultra violet oxidation stabilizers for plastics	plastics and dyes
35	1,2,4-Trimethylbenzene	(pseudocumene)	solvent; dye & perfume manufacture	misc. solvent usage; diesel exhaust fumes

36	1,3-Dichlorobenzene	(m-dichlorobenzene)	fumigant and insecticide	pesticide and fumigation applications
37	Decane	n-Decane	organic synthesis, solvent, jet fuel	airport operations
38	1,4-Dichlorobenzene	(p-dichlorobenzene)	toilet packs	
39	1,2-Dichlorobenzene	(o-dichlorobenzene)	organic solvent; detergent of grease; insecticide; heat transfer medium; disinfectant; dye intermediate	pesticide application; solvent usage
40	1,3-Diethylbenzene		(usually a mixture of isomers)	intermediate solvent
41	Undecane	n-Undecane	organic synthesis, distillation chaser	petroleum research
42	1,2,4-Trichlorobenzene		chlorination of monochlorobenzene dielectric fluid, synthetic transformer oils, lubricants and insecticides	solvent, dyes and intermediates
43	Naphthalene	(tar camphor)	intermediates; fungicide; explosives; cutting fluid; uncontrolled emissions from small synthetic resins; synthetic tanning; preservative; solvent; textile chemicals; emulsion breakers; scintillation counters; mothballs	misc. solvent usage; industries
44	Dodecane	n-Dodecane	solvent, organic synthesis, distillation chaser, jet fuel	airport operations
45	Tridecane	n-Tridecane	organic synthesis, distillation chaser	petroleum research

APPENDIX B
(The Field Work and Results)

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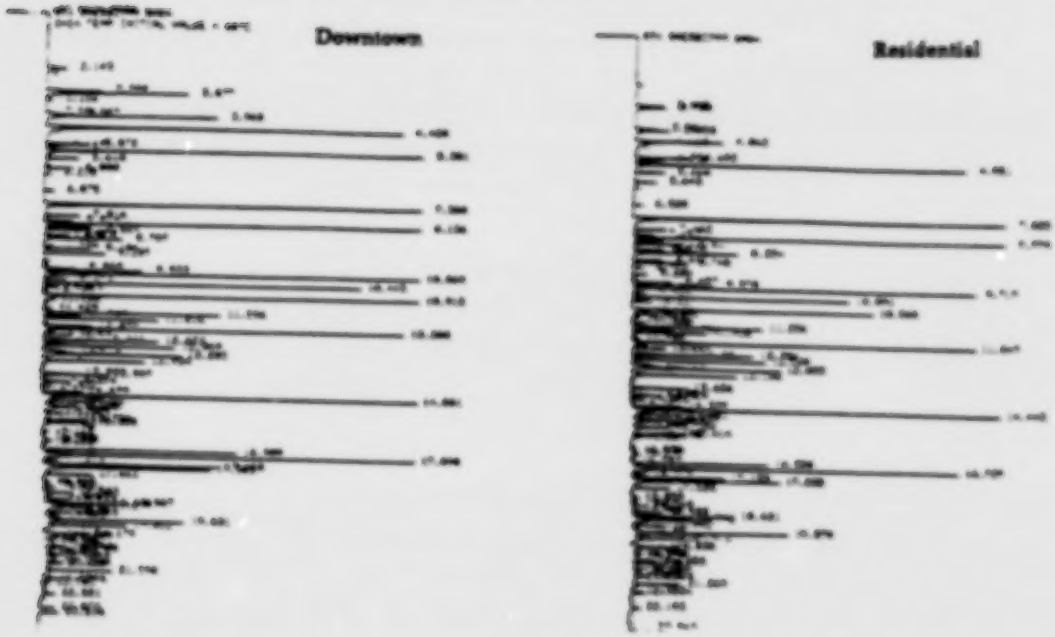
Figure 1
Representative Chromatographic VOC Fingerprints

The Outdoor Environments



The Indoor Environments

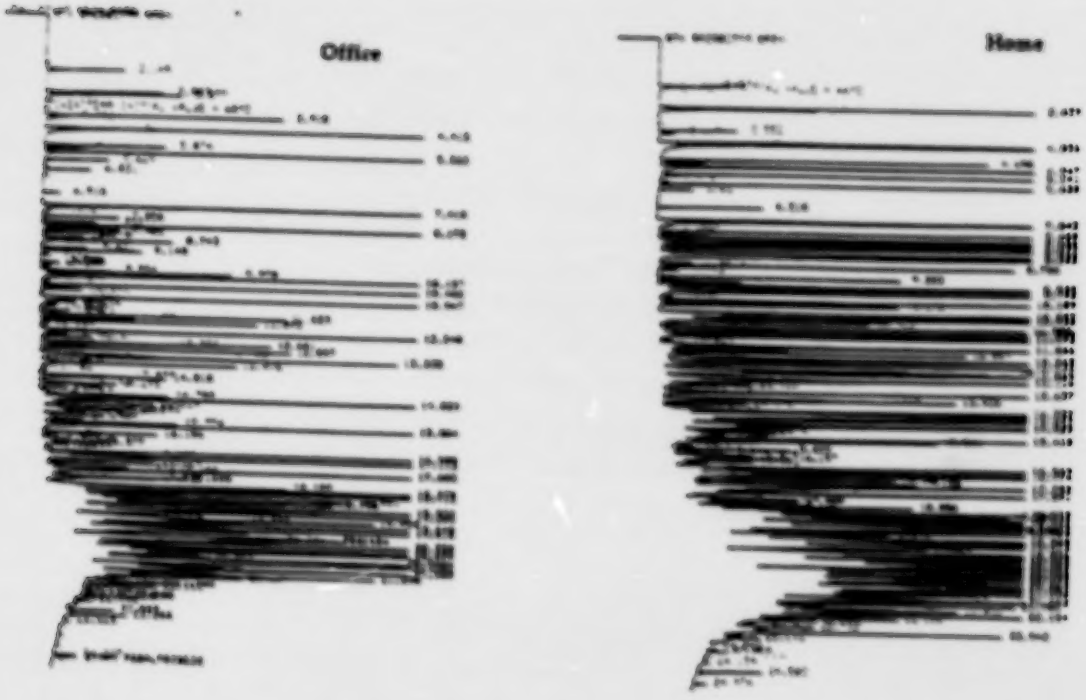
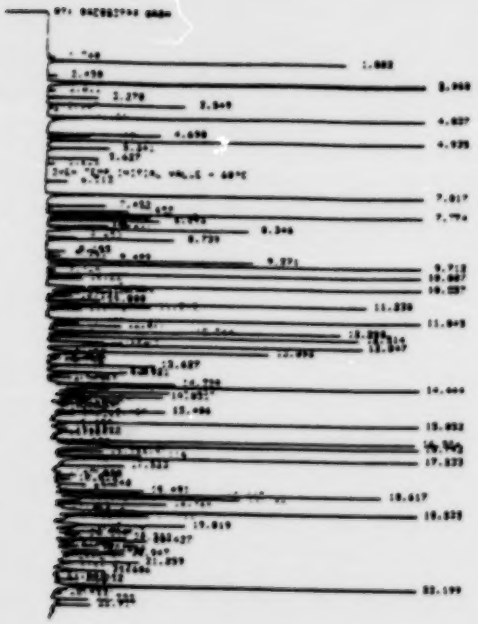


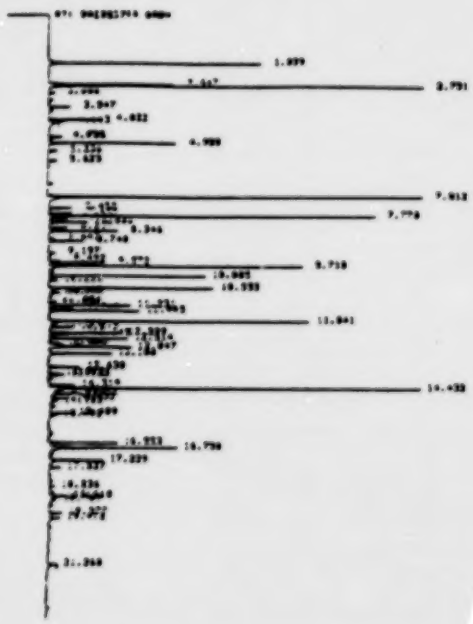
Figure 2
Representative Chromatographic VOC Fingerprints

The Commuting and Noon-Hour Programmes

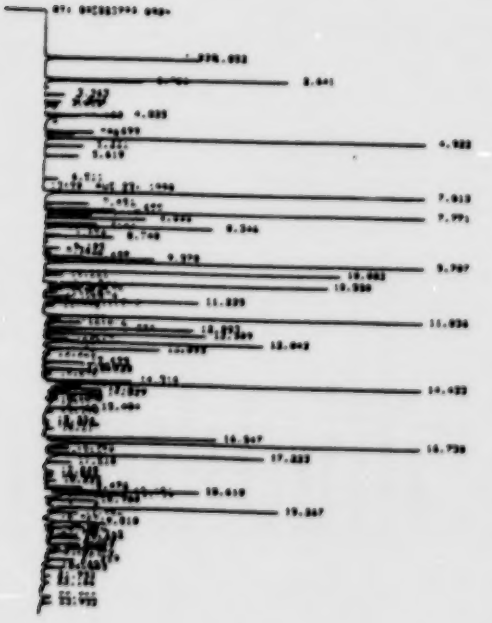
Morning Commute



Noon-Hour Walk-About



Afternoon Commute



Personal Exposure Pilot Study - Indoor Air at 880 Bay Street (Regular Office Hours)

Sample Identification	RB WK2	RB WK3	BK WK4	ML WK5	RB WK6	BK WK7	RB WK8	LAB WK9	
	2	2	7	7	7	7	4	4	
Date sampled:	06/20/90	06/28/90	07/13/90	07/18/90	08/09/90	08/15/90	08/21/90	08/29/90	
Sampling period:	0930-1530	0900-1530	0920-1520	0931-1631	1000-1645	0915-1615	0920-1620	0845-1630	Avg.
1 PROPANE	27.3	4.8	1.4	5.6	1.7	2.8	1.6	3.0	6.0
2 CHLOROMETHANE	9.0	3.5	7.8	4.1	1.8	T	T		3.7
3 CHLOROETHENE									
4 1,3-BUTADIENE		T		T					
5 BUTANE	18.6	16.9	9.2	27.3	3.6	2.8	2.4	2.8	10.4
6 PENTANE	23.3	12.9	7.5	23.3	5.4	2.1	1.8	6.2	10.3
7 ACRYLONITRILE									
8 ISOPRENE	T				T		T	T	
9 1,1-DICHLOROETHENE	8.2	4.9	1.4	20.2	1.4	T	0.9	2.7	5.0
10 DICHLOROMETHANE	T	3.0	T	4.5	T	T	T	4.2	1.5
11 HEXANE	31.6	23.0	5.3	28.7	3.6	1.6	1.9	1.4	12.1
12 TRICHLOROMETHANE								T	
13 1,2-DICHLOROETHANE				3.8					3.8
14 1,1,1-TRICHLOROETHANE	61.8	12.0	8.8	64.6	17.8	6.8	T	24.1	24.5
15 BENZENE	20.5	11.5	6.0	18.9	3.3	1.1	1.1	1.1	7.9
16 TETRACHLOROMETHANE	33.3	16.3	9.9	34.7	T	T	T	T	11.8
17 CYCLOHEXANE	2.1		0.6	4.8	0.6	T	0.4	T	1.2
18 1,2-DICHLOROPROPANE									
19 TRICHLOROETHENE	15.6	8.7	8.2	80.8	7.0	3.0	T	2.6	15.7
20 HEPTANE	7.9	5.2	2.3	12.5	1.3	T	T	T	3.6
21 1,1,2-TRICHLOROETHANE									
22 TOLUENE	55.0	39.5	19.6	63.2	9.4	4.3	4.6	3.5	24.9
23 1,2-DIBROMOETHANE									
24 OCTANE	3.2	2.2	1.2	2.5	T	T	T	T	1.1
25 TETRACHLOROETHENE	22.9	23.3	19.4	34.9	2.5	2.1	5.9	T	13.9

Table 1

Personal Exposure Pilot Study - Indoor Air at 880 Bay Street (Regular Office Hours)

Sample Identification	RB WK2	RB WK3	BK WK4	ML WK5	RB WK6	BK WK7	RB WK8	LAB WK9	
	2	2	7	7	7	7	4	4	
Date sampled:	06/20/90	06/28/90	07/13/90	07/18/90	08/09/90	08/15/90	08/21/90	08/29/90	
Sampling period:	0930-1530	0900-1530	0920-1520	0931-1631	1000-1645	0915-1615	0920-1620	0845-1630	Avg.
26 CHLOROBENZENE	T	2.3	T	3.1	T	T	T	T	0.7
27 ETHYLBENZENE	10.0	7.9	4.1	6.0	2.0	0.8	0.5	0.7	4.0
28 M-XYLENE	27.8	22.3	11.0	17.8	5.9	2.2	1.4	2.0	11.3
29 P-XYLENE	T	3.9		5.7	1.7	T	T	T	1.6
TOTAL M,P-XYLENES									
30 STYRENE	8.1	6.1	2.9	5.5	1.6	T	T	T	3.0
31 1,1,2,2-TETRACHLOROETHANE	T	2.9	T	2.8	T	T	T	T	0.7
32 O-XYLENE	9.9	31.5	2.9	6.4	2.9	1.1	0.7	0.9	7.0
33 NONANE	12.0	11.0	4.8	9.7	1.6	T	T	1.0	5.0
34 1,3,5-TRIMETHYLBENZENE	19.0	17.8	3.7	20.0	7.8	2.6	T	T	8.9
35 1,2,4-TRIMETHYLBENZENE									
36 DECANE	7.4	25.9	3.6	34.6	3.2	1.1	0.7	1.0	9.7
37 1,3-DICHLOROBENZENE									
38 1,4-DICHLOROBENZENE	7.6		2.0		4.0	1.3	T	0.9	2.6
39 1,2-DICHLOROBENZENE	7.6	20.2	T	15.6	8.1	T	T	T	6.4
40 1,2-DIETHYLBENZENE									
41 UNDECANE			T	T	T	T		T	
42 1,2,4-TRICHLOROBENZENE	T	3.2	T	T	T	T		T	0.5
43 NAPHTHALENE	T	2.3							1.2
44 DODECANE									
45 TRIDECANE									
Number of Compounds Detected	31	29	29	31	31	30	29	31	

All concentration units are ug/m3

RB, BK and ML refer to different staff members

WK = week

T = Concentrations less than Method Quantitation Limit (MQL) but greater than Method Detection Limit (MDL)

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Table 1 ctd.

Table 2

Personal Exposure Pilot Study - Indoor Air Comparisons
(At 880 Bay Street; Regular Office Hours)

		June & July Samples Avg.	August Samples Avg.
1	PROPANE	9.8	2.3
2	CHLOROMETHANE	6.1	0.6
3	BUTANE	18.0	2.9
4	PENTANE	16.7	3.9
5	1,1-DICHLOROETHENE	8.7	1.2
6	DICHLOROMETHANE	1.9	1.1
7	HEXANE	22.2	2.1
8	TRICHLOROMETHANE		
9	1,2-DICHLOROETHANE	3.8	
10	1,1,1-TRICHLOROETHANE	36.8	12.2
11	BENZENE	14.2	1.6
12	TETRACHLOROMETHANE	23.5	
13	TRICHLOROETHENE	28.3	3.1
14	TOLUENE	44.3	5.5
15	TETRACHLOROETHENE	25.1	2.6
16	ETHYLBENZENE	7.0	1.0
17	TOTAL M,P-XYLENES	22.9	3.3
18	STYRENE	5.6	0.4
19	NONANE	9.4	0.6
20	1,3,5-TRIMETHYLBENZENE	15.1	2.6
21	DECANE	17.9	1.5
22	1,2-DICHLOROBENZENE	10.9	2.0

All concentration units are ug/m3
C:\SYMPHONY\PEP\INWKCOM.WR1

Figure 3

Personal Exposure Pilot Study
Office : Indoor Air Comparisons
Concentration (ug/m3)
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Volatile Organic Compounds
August Samples
June & July Samples
Regular Office Hours

Personal Exposure Pilot Study - Indoor Air (Domestic)

"SPECIALS!!"

	EP WK1	BK WK3	BK WK8	RB WK9		EP WK1	MS WK2	MS WK2	RB WK4
Sample:	3	3	2	2		5	5	6	R1272
Date sampled:	06/14	06/28	08/20-21	08/28-29		06/16/90	06/20/90	06/20/90	07/12-13/90
Sampling Start Time:	2145-0753	1810-2210	1900-0700	1830-0630		1747-1932	1910-2010	2142-2212	1630-0830
					Avg.	at a "BBQ"	at a "Meeting"	at a "Meeting"	work to home to work
1 PROPANE	1.4	4.6	0.6	2.4	2.2	2.1	8.7	T	1.2
2 CHLOROMETHANE		12.5	1.3	2.6	5.5	18.9	6.5		17.7
3 CHLOROETHENE									
4 1,3-BUTADIENE		T	T	T					2.7
5 BUTANE	7.4	14.8	30.6	42.8	23.9	2.0	5.8	T	59.1
6 PENTANE	12.4	14.0	23.6	28.3	19.6	3.3	7.3	4.3	34.7
7 ACRYLONITRILE									
8 ISOPRENE		4.4	5.8	5.3	5.2	T	6.1		2.2
9 1,1-DICHLOROETHENE	1.9	9.0			5.4				4.6
10 DICHLOROMETHANE	5.0	15.1	35.0	1.4	14.1	T	T		2.7
11 HEXANE	6.3	11.8	16.1	13.8	12.0	2.1	4.6	T	18.0
12 TRICHLOROMETHANE	5.7	14.9	13.2	14.2	12.0				10.8
13 1,2-DICHLOROETHANE				3.6	3.6				
14 1,1,1-TRICHLOROETHANE	8.7	28.1	20.2	6.1	15.8				7.1
15 BENZENE	2.6	12.4	11.2	12.1	9.6	2.9	5.6	T	16.0
16 TETRACHLOROMETHANE	T	23.7	17.3	13.2	13.5	T	T		21.8
17 CYCLOHEXANE	0.7	1.2	1.5	0.9	1.1		T		1.1
18 1,2-DICHLOROPROPANE									
19 TRICHLOROETHENE	T	5.3	6.9	3.1	3.8		T		9.4
20 HEPTANE	1.7	4.8	6.6	4.8	4.5	T	T	T	5.6
21 1,1,2-TRICHLOROETHANE									
22 TOLUENE	23.9	89.2	76.0	43.0	58.0	2.4	14.0	6.0	73.2
23 1,2-DIBROMOETHANE									
24 OCTANE	1.1	3.9	2.3	1.5	2.2	T	T	T	2.7
25 TETRACHLOROETHENE		9.0	5.5	2.8	5.8				4.8

Personal Exposure Pilot Study - Indoor Air (Domestic)

"SPECIALS!!"

	EP WK1	BK WK3	BK WK8	RB WK9		EP WK1	MS WK2	MS WK2	RB WK4
Sample:	3	3	2	2		5	5	6	R1272
Date sampled:	06/14	06/28	08/20-21	08/28-29		06/16/90	06/20/90	06/20/90	07/12-13/90
Sampling Start Time:	2145-0753	1810-2210	1900-0700	1830-0630		1747-1932	1910-2010	2142-2212	1630-0830
					Avg.	at a "BBQ"	at a "Meeting"	at a "Meeting"	work to home to work
26 CHLOROBENZENE	0.3	T	0.8	T	0.3				1.0
27 ETHYLBENZENE	3.4	12.0	6.2	8.0	7.4	T	2.3	T	9.4
28 M-XYLENE	5.7	38.7	18.1	26.7	22.3	T	5.9	T	31.5
29 P-XYLENE	7.0		1.0	1.7	3.2	T			3.9
TOTAL M,P-XYLENES	6.3				6.3	T			
30 STYRENE		12.5	5.2	7.5	8.4		T		9.6
31 1,1,2,2-TETRACHLOROETHANE		7.5	4.6	1.2	4.5				2.5
32 O-XYLENE	2.2	7.2	3.8	2.6	4.0	T	T		4.0
33 NONANE	1.7	22.5	10.3	6.1	10.1		T		13.6
34 1,3,5-TRIMETHYLBENZENE	1.1	15.1	14.1	2.0	8.1				5.3
35 1,2,4-TRIMETHYLBENZENE	3.1				3.1	T			
36 DECANE	3.4	6.2	1.6	21.9	8.3				7.6
37 1,3-DICHLOROBENZENE	3.5		2.7		3.1				
38 1,4-DICHLOROBENZENE	1.5	T	1.4	T	0.7				0.5
39 1,2-DICHLOROBENZENE		15.3	15.6	2.7	11.2				6.8
40 1,2-DIETHYLBENZENE									T
41 UNDECANE	2.5		4.1	1.5	2.7				2.6
42 1,2,4-TRICHLOROBENZENE		7.2	1.3	1.0	3.1				2.6
43 NAPHTHALENE		4.8			4.8				
44 DODECANE	T								
45 TRIDECANE	T								
Number of VOCs Detected	30	32	33	33		18	19	10	34

All concentrations are in ug/m3

EP, RB, MS AND BK = Different Staff Members

WK = Week

T = Concentrations less than the Method Quantitation Limit (MQL) BUT greater than the Method Detection Limit (MDL)

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Table 3 ctd.

Table 4

Personal Exposure Pilot Study - College Street VOC Results (12-hour samples)

Sample Identification	CS WK1 1	CS WK1 2	CS WK2 8	CS WK3 1	CS WK3 2	CS WK4 1	CS WK4 2	CS WK5 1	CS WK5 2	CS WK6 2	CS WK7 1	CS WK7 2	CS WK8 1	CS WK8 2	CS WK9 1	CS WK9 2	
Date sampled:	06/12	06/12	06/20	06/28	06/28	07/12	07/12	07/18	07/18	08/09	08/15	08/15	08/21	08/21	08/29	08/29	
Sampling Start Time:	0700	1900	1900	0700	1900	0700	1900	0700	1900	0700	0700	1900	0700	1900	0700	1900	Avg.
1 PROPANE	2.2	13.3	2.0	4.6	7.3	16.2	3.5	1.8	0.5	0.4	T	0.6	0.5	0.7	5.4	10.9	4.4
2 CHLOROMETHANE	1.3	1.5	1.9	T	T	T	1.7			T		T	T	2.4	T	1.2	0.8
3 CHLOROETHENE																	
4 1,3-BUTADIENE						T					T	T	T				
5 BUTANE	6.2	5.1	8.6	3.2	3.7	7.2	2.0	6.1	4.4	3.9	5.4	6.5	4.0	4.4	4.5	6.8	5.1
6 PENTANE	7.7	4.3	7.0	5.8	3.2	5.4	2.0	4.2	4.1	5.2	5.2	7.1	4.2	3.9	7.0	5.0	5.1
7 ACRYLONITRILE																	
8 ISOPRENE			T	T				T	T	T	T	T	T	T	T	T	
9 1,1-DICHLOROETHENE										1.7	1.6	2.5	1.7	1.5	2.5	1.8	1.9
10 DICHLOROMETHANE	T	T	T	T	T	T		T	T	T	T	T	T	T	T	T	
11 HEXANE	6.0	8.8	14.9	7.0	1.8	2.9	1.1	3.1	2.4	2.9	4.2	4.7	3.0	2.2	3.6	1.7	4.4
12 TRICHLOROMETHANE						3.3				T							1.7
13 1,2-DICHLOROETHANE																	
14 1,1,1-TRICHLOROETHANE	T	T	T	T	T	T		T	T	T	T	T	T	T	T	T	
15 BENZENE	5.1	2.0	2.8	3.2	1.6	3.0	1.6	2.7	2.3	2.6	2.9	4.5	2.9	2.3	4.2	2.3	2.9
16 TETRACHLOROMETHANE	T	T	T	T	T	T		T	T	T	T	T	T	T	T	T	
17 CYCLOHEXANE	T	T	T	T		0.5	T	T	T	T	0.5	0.6	0.4	T	0.5	T	0.2
18 1,2-DICHLOROPROPANE																	
19 TRICHLOROETHENE	T			T		T		2.2	T		T	T	T	T	T		0.2
20 HEPTANE	1.9	T	T	1.2	T	1.2	T	T	1.1	T	1.4	2.0	1.3	T	1.3	T	0.7
21 1,1,2-TRICHLOROETHANE																	
22 TOLUENE	519.8	13.8	6.1	9.1	5.9	9.3	3.4	6.3	7.5	6.9	8.5	13.9	7.5	5.6	10.8	5.1	8.8**
23 1,2-DIBROMOETHANE																	
24 OCTANE	0.9	T	T	T	T	T	T	T	T	T	T	0.8	T	T	T	T	0.1
25 TETRACHLOROETHENE	2.9	T	T	T	T	T	T	4.8	T	T	2.5	T	T	T	T	T	0.6

Personal Exposure Pilot Study - College Street VOC Results (12-hour samples)

Table 4 ctd.

Sample Identification	CS WK1 1	CS WK1 2	CS WK2 8	CS WK3 1	CS WK3 2	CS WK4 1	CS WK4 2	CS WK5 1	CS WK5 2	CS WK6 2	CS WK7 1	CS WK7 2	CS WK8 1	CS WK8 2	CS WK9 1	CS WK9 2	
Date sampled:	06/12	06/12	06/20	06/28	06/28	07/12	07/12	07/18	07/18	08/09	08/15	08/15	08/21	08/21	08/29	08/29	
Sampling Start Time:	0700	1900	1900	0700	1900	0700	1900	0700	1900	0700	0700	1900	0700	1900	0700	1900	Avg.
26 CHLOROBENZENE						T											
27 ETHYLBENZENE	2.6	0.7	0.8	1.6	0.8	1.8	0.7	0.8	1.4	1.3	1.5	4.0	1.4	0.8	2.2	0.6	1.4
28 M-XYLENE	6.5	1.8	1.9	4.5	2.2	4.9	1.9	1.6	3.7	3.2	4.0	11.1	3.6	2.2	6.0	1.6	3.8
29 P-XYLENE	7.9	2.2	T	T	T	T			T	T	T	1.7	T	T	T	T	0.8
TOTAL M,P-XYLENES	7.2	2.0															4.6
30 STYRENE	T		T	T	T	1.4	T	T	T	T	T	3.2	T	T	1.9	T	0.4
31 1,1,2,2-TETRACHLOROETHANE			T	T	T	T	T		T	T	T	T	T		T		
32 O-XYLENE	2.1	T	T		T	0.7	T	T	0.5	0.6	0.6	1.1	0.6	T	1.1	T	0.5
33 NONANE	T		T		T	1.5	T	T	1.2	1.2	1.3	2.2	1.4	T	2.4	T	0.8
34 1,3,5-TRIMETHYLBENZENE	1.2	T	T			T				T		T	T		T		0.1
35 1,2,4-TRIMETHYLBENZENE	2.5	T										0.6					1.0
36 DECANE	T		T			0.7			T	T	T	0.9	T	T	0.6		0.2
37 1,3-DICHLOROBENZENE												0.6					0.6
38 1,4-DICHLOROBENZENE	0.7	T															0.3
39 1,2-DICHLOROBENZENE			T	T		T			T	T		T	T	T	T	T	
40 1,2-DIETHYLBENZENE																	
41 UNDECANE	T											T	T	T			
42 1,2,4-TRICHLOROBENZENE													T				
43 NAPHTHALENE																	
44 DODECANE	T																
45 TRIDECANE																	
Number of Compounds Detected	28	22	25	22	20	28	17	20	24	27	25	31	30	26	27	23	

** This average concentration does NOT include the outlier: 520 ug/m3.

All concentrations are in ug/m3

CS = College Street

WK = Week

T = Concentrations less than the Method Quantitation Limit (MQL) BUT greater than the Method Detection Limit (MDL)

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Personal Exposure Pilot Study - Garnock Avenue VOC Results (12-hour samples)

Sample Identification	NR VA1 1	NR VA2 1	NR VA3 2	NR VA8 1	NR VA8 2	NR VA9 1	NR VA9 2	
Date sampled:	06/12	06/20	06/28-29	08/21	08/21-22	08/29	08/29-30	
Sampling period:	0700-1900	0700-1900	1900-0700	0750-1930	1930-0730	0700-1900	1900-0700	Avg.
1 PROPANE	3.4	2.3	?	?	?	0.6	2.3	1.2
2 CHLOROMETHANE	?	?	?	?		?	?	
3 CHLOROETHENE								
4 1,3-BUTADIENE								
5 BUTANE	15.6	5.9	10.2	1.0	0.9	1.4	4.0	5.6
6 PENTANE	9.2	6.0	8.6	1.2	1.0	2.0	2.6	4.4
7 ACRYLONITRILE								
8 ISOPRENE	?	?				?		
9 1,1-DICHLOROETHENE				?	?	0.8	0.9	0.4
10 DICHLOROMETHANE	?	?	?	?	?		?	
11 HEXANE	12.2	6.8	4.9	0.8	?	1.0	1.3	3.8
12 TRICHLOROMETHANE								
13 1,2-DICHLOROETHANE								
14 1,1,1-TRICHLOROETHANE	?	?		?		?	?	
15 BENZENE	3.6	2.9	4.5	0.7	0.6	1.1	1.0	2.0
16 TETRACHLOROMETHANE	11.2	?	?	?		?	?	1.9
17 CYCLOHEXANE		?	?	?		?	?	
18 1,2-DICHLOROPROPANE								
19 TRICHLOROETHENE	?	?						
20 HEPTANE	1.5	1.2	?	?		?	?	0.4
21 1,1,2-TRICHLOROETHANE								
22 TOLUENE	10.3	8.9	15.9	1.9	1.3	3.7	3.7	6.5
23 1,2-DIBROMOETHANE								
24 OCTANE	?	?	?	?		?	?	
25 TETRACHLOROETHENE	?	?	?			7.9	?	1.6

Table 6

Personal Exposure Pilot Study - Garnock Avenue VOC Results (12-hour samples)

Sample Identification	HR WK1 1	HR WK2 1	HR WK3 2	HR WK8 1	HR WK8 2	HR WK9 1	HR WK9 2	
Date sampled:	06/12	06/20	06/28-29	08/21	08/21-22	08/29	08/29-30	
Sampling period:	0700-1900	0700-1900	1900-0700	0730-1930	1930-0730	0700-1900	1900-0700	Avg.
26 CHLOROBENZENE								
27 ETHYLBENZENE	1.6	1.9	2.1	T	T	0.7	0.9	1.0
28 M-XYLENE	3.8	4.5	5.5	0.8	T	1.9	2.5	2.7
29 P-XYLENE	4.7	T		T	T	T	T	0.8
TOTAL M,P-XYLENES	4.3							4.3
30 STYRENE	T	T	T	T		T	T	
31 1,1,2,2-TETRACHLOROETHANE		T						
32 O-XYLENE	T	0.5		T		T	T	0.1
33 NONANE	T	1.2		T		T	T	0.2
34 1,3,5-TRIMETHYLBENZENE	0.5	T						0.2
35 1,2,4-TRIMETHYLBENZENE	1.3							1.3
36 DECANE	T						T	
37 1,3-DICHLOROBENZENE								
38 1,4-DICHLOROBENZENE	T							
39 1,2-DICHLOROBENZENE		T		T				
40 1,2-DIETHYLBENZENE								
41 UNDECANE	T							
42 1,2,4-TRICHLOROBENZENE								
43 NAPHTHALENE								
44 DODECANE								
45 TRIDECANE								
Number of Compounds Detected	27	25	16	21	11	21	22	

All concentration units are ug/m3

HR = Staff Member's Residence

WK = Week

T = Concentrations less than the Method Quantitation Limit (MQL) BUT greater than the Method Detection Limit (MDL)

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Table 5 ctd.

Table 6

PEPS 1990 VOC Results - Ambient Concentrations
(Diurnal Variations)

	Downtown Samples		Residential Samples	
Sample: / Date sampled:	Night-time Averages	Day-time Averages	Night-time Averages	Day-time Averages
1 PROPANE	4.9	3.9	0.8	1.6
2 CHLOROMETHANE	1.3	0.2		
3 BUTANE	5.2	5.1	5.0	6.0
4 PENTANE	4.6	5.6	4.1	4.6
5 1,1-DICHLOROETHENE	1.9	1.9	0.5	0.4
6 DICHLOROMETHANE				
7 HEXANE	4.7	4.1	2.0	5.2
8 TRICHLOROMETHANE		1.7		
9 1,2-DICHLOROETHANE				
10 1,1,1-TRICHLOROETHANE				
11 BENZENE	2.4	3.3	2.0	2.1
12 TETRACHLOROMETHANE				2.8
13 TRICHLOROETHENE		0.3		
14 TOLUENE	7.7	8.3	7.0	6.2
15 TETRACHLOROETHENE		1.2		2.6
16 ETHYLBENZENE	1.2	1.6	1.0	1.0
17 TOTAL M,P-XYLENES	3.8	5.4		3.9
18 STYRENE	0.5	0.4		
19 NONANE	0.5	1.1		0.3
20 1,3,5-TRIMETHYLBENZENE		0.2		0.2
21 DECANE	0.2	0.2		
22 1,2-DICHLOROBENZENE				
Number of VOCs Detected	13	17	8	13

All concentration units are ug/m3
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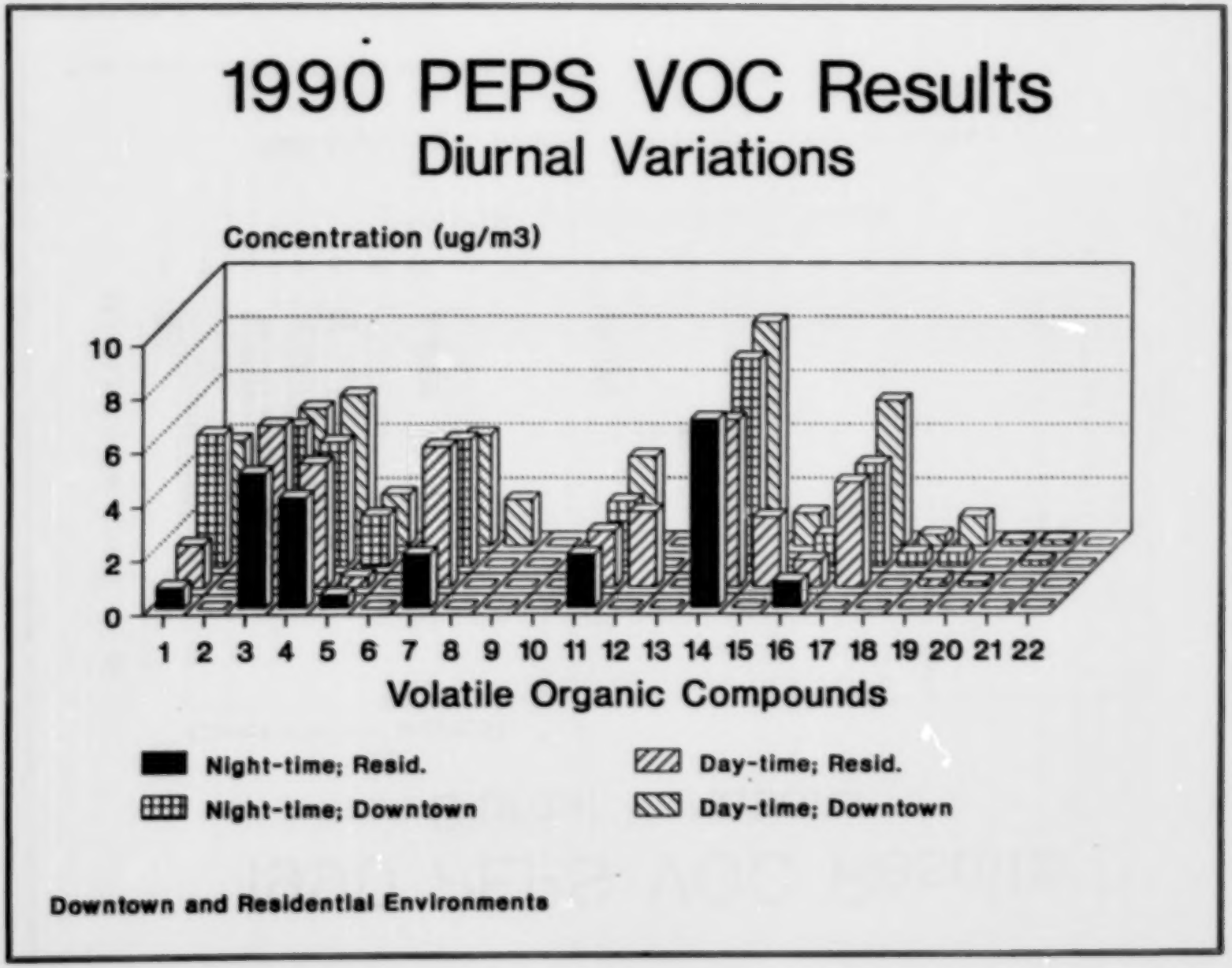
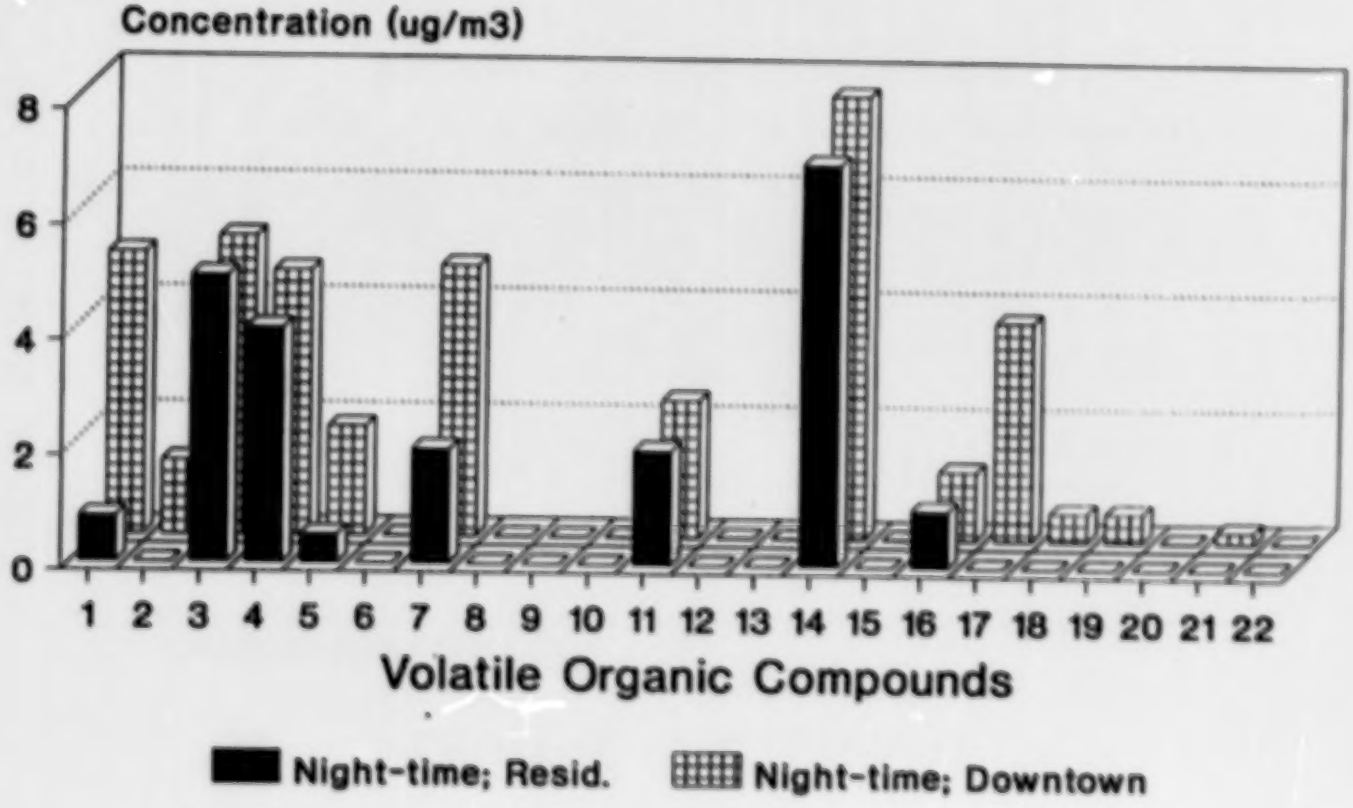

1990 PEPS VOC Results
Diurnal Variations
Concentration (ug/m3)
10
8
6
4
2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Volatile Organic Compounds
Night-time; Resid.
Night-time; Downtown
Day-time; Resid.
Day-time; Downtown
Downtown and Residential Environments

Figure 4

1990 PEPS VOC Results
Diurnal Variations



Downtown and Residential Environments

Figure 5

Table 7

PEPS 1990 VOC Results

Outdoor versus Indoor Air Quality

		Outdoor		Indoor	
		Downtown	Residential	Office	Domestic
	Number of Samples	(16)	(7)	(8)	(4)
1	PROPANE	4.4	1.2	6.0	2.2
2	CHLOROMETHANE	0.8	0.0	3.7	5.5
3	BUTANE	5.1	5.6	10.4	23.9
4	PENTANE	5.1	4.4	10.3	19.6
5	1,1-DICHLOROETHENE	1.9	0.4	5.0	5.4
6	DICHLOROMETHANE	0.0	0.0	1.5	14.1
7	HEXANE	4.4	3.8	12.1	12.0
8	TRICHLOROMETHANE	1.7	0.0	0.0	12.0
9	1,2-DICHLOROETHANE	0.0	0.0	3.8	3.6
10	1,1,1-TRICHLOROETHANE	0.0	0.0	24.5	15.8
11	BENZENE	2.9	2.0	7.9	9.6
12	TETRACHLOROMETHANE	0.0	1.9	11.8	13.5
13	TRICHLOROETHENE	0.2	0.0	15.7	3.8
14	TOLUENE	** 8.0	6.5	24.9	58.0
15	TETRACHLOROETHENE	0.6	1.6	13.9	5.8
16	ETHYLBENZENE	1.4	1.0	4.0	7.4
17	TOTAL M,P-XYLENES	4.6	3.5	12.9	25.5
18	STYRENE	0.4	0.0	3.0	8.4
19	NONANE	0.8	0.2	5.0	10.1
20	1,3,5-TRIMETHYLBENZENE	0.1	0.2	8.9	8.1
21	DECANE	0.2	0.0	9.7	8.3
22	1,2-DICHLOROBENZENE	0.0	0.0	6.4	11.2

Concentration units are ug/m3

** The high downtown toluene outlier concentration (520 ug/m3) was removed from the outdoor data set.

The above data were analyzed from samples exposed for 8 to 12-hours.

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Personal Exposure Pilot Study
Outdoor Versus Indoor Air Quality

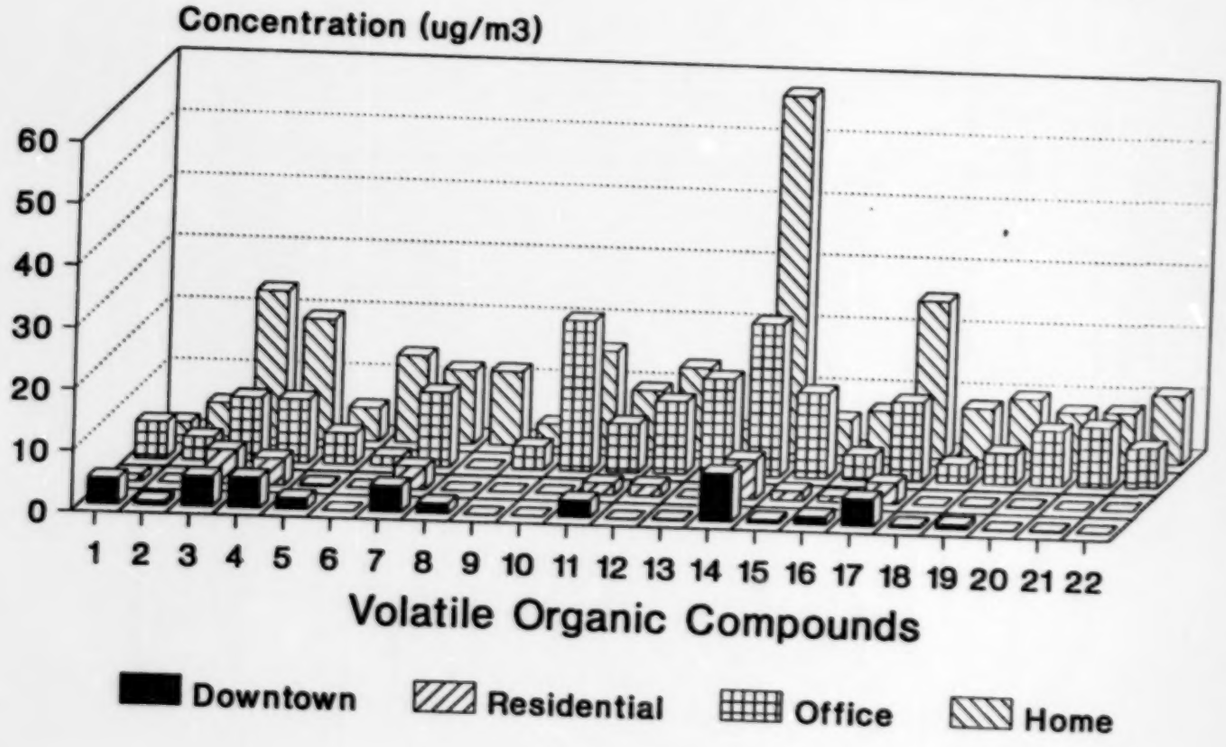
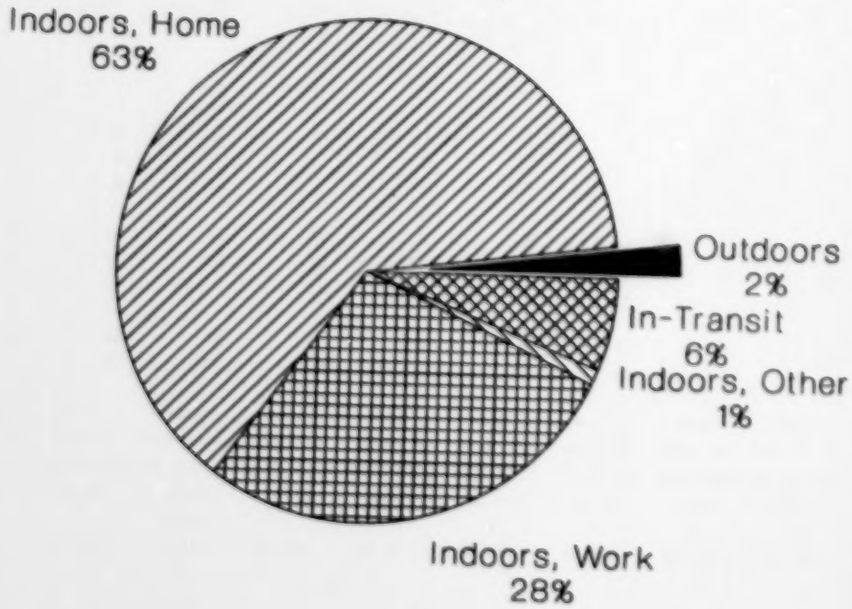


Figure 6

Time Budget Analyses
Employed People (44 U.S. Cities)



W.R. Ott; APCA-88-115.1

Figure 7

Personal Exposure pilot Study - Morning Commuter Run (1 to 2-hour Samples)

Sample Identification	EP WK1	EP WK1	MS WK2	EP WK2	BK WK3	RB WK4	RC WK5	MS WK6	MS WK7	BK WK8	RB WK9	
	1	4	1	EWP#6	1	R1273	6	6	6	3	3	
Date sampled:	06/12	06/15	06/20	06/21	06/28	07/13	07/18	08/10	08/15	08/21	08/29	
Sampling period:	0651-0747	0823-0931	0730-0830	0656-0751	0700-0750	0700-0850	0735-0855	0700-0800	0800-0840	0700-0745	0630-0830	
Description:	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	Avg.
1 PROPANE	15	14	52	20	7	6	14	25	10	3	6	15.6
2 CHLOROMETHANE	50	18	13	65		100	310	13	T	T	2	57.1
3 CHLOROETHENE												
4 1,3-BUTADIENE			5		T			T			T	1.3
5 BUTANE	14	10	95	15	18	4	11	22	24	12	8	21.1
6 PENTANE	28	18	160	21	18	4	9	24	16	12	9	28.9
7 ACRYLONITRILE												
8 ISOPRENE		T	13	T		T	T		T	T		1.9
9 1,1-DICHLOROETHENE			3			2	3		6	8		4.3
10 DICHLOROMETHANE	T	T	12	T	T	T	T	T	T		T	1.2
11 HEXANE	15	9	88	14	15	2	7	20	10	7	5	17.3
12 TRICHLOROMETHANE												
13 1,2-DICHLOROETHANE			19									18.7
14 1,1,1-TRICHLOROETHANE			T		T	7	T	T		T	T	1.0
15 BENZENE	18	14	125	21	17	2	6	25	19	6	5	23.5
16 TETRACHLOROMETHANE	T	T	115	29	20		T	33	T	T	T	19.7
17 CYCLOHEXANE	T	T	6	T	1	T	T	2	T	T	T	0.8
18 1,2-DICHLOROPROPANE												
19 TRICHLOROETHENE	T	T	8	T	8	5	T	8		T	T	2.9
20 HEPTANE	5	T	23	5	5	T	T	7	T	T	2	4.2
21 1,1,2-TRICHLOROETHANE												
22 TOLUENE	41	26	160	54	45	10	33	52	24	16	15	43.2
23 1,2-DIBROMOETHANE												
24 OCTANE	T	T	6	T	2	T	T	3	T	T	1	1.1
25 TETRACHLOROETHENE	13	T	24				T	T	37	T	5	9.8

Table 8

Personal Exposure pilot Study - Morning Commuter Run (1 to 2-hour Samples)

Sample Identification	EP WK1	EP WK1	MS WK2	EP WK2	BK WK3	RB WK4	RC WK5	MS WK6	MS WK7	BK WK8	RB WK9	
	1	4	1	EWP#6	1	R1273	6	6	6	3	3	
Date sampled:	06/12	06/15	06/20	06/21	06/28	07/13	07/18	08/10	08/15	08/21	08/29	
Sampling period:	0651-0747	0823-0931	0730-0830	0656-0751	0700-0750	0700-0850	0735-0855	0700-0800	0800-0840	0700-0745	0630-0830	
Description:	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	home to work	Avg.
26 CHLOROBENZENE					T	T					T	
27 ETHYLBENZENE	7	5	7	8	7	1	2	10	3	2	2	5.0
28 M-XYLENE	16	13	24	25	24	4	5	30	7	7	7	14.7
29 P-XYLENE	20	16	7	T			T	T			T	6.1
TOTAL M,P-XYLENES	18	14										16.2
30 STYRENE	T		8	7	7	T	T	9	T	T	2	3.3
31 1,1,2,2-TETRACHLOROETHANE			T		T	T		T			T	
32 O-XYLENE	5	4	1	3	4			5	T	T	2	2.7
33 NONANE	T	T		8	9	2	T	12	T	T	4	3.5
34 1,3,5-TRIMETHYLBENZENE	3	2	T		T	T		T			T	0.7
35 1,2,4-TRIMETHYLBENZENE	6	6										5.6
36 DECANE		T	T		2	1	2	2		T	4	1.4
37 1,3-DICHLOROBENZENE					T							
38 1,4-DICHLOROBENZENE					T	T					T	
39 1,2-DICHLOROBENZENE			T		T	T	T	T			4	0.7
40 1,2-DIETHYLBENZENE												
41 UNDECANE						T	T	T			3	0.8
42 1,2,4-TRICHLOROBENZENE			T	T	T	T	T	T			5	0.7
43 NAPHTHALENE			T		T							
44 DODECANE												
45 TRIDECANE												
Number of Compounds Detected	23	24	30	21	28	27	26	28	20	22	30	

EP, MS, BK, RC and RB refer to staff members
All concentrations are ug/m3
T = Concentration less than the Method Quantitation Limit (MQL) BUT greater than the Method Detection Limit (MDL)
C:\SYMPHONY\PEP\THWCOM.WR1

Table 8 ctd.

Personal Exposure Pilot Study - Afternoon Commuter Run (1 to 2-hour Samples)

Sample Identification	EP WK1	BK WK3	RB WK4	RC WK5	MS WK6	MS WK7	BK WK8	RB WK9	
	2	2	R1271	4	4	4	1	1	
Date sampled:	06/12/90	06/28/90	07/12/90	07/17/90	08/09/90	08/14/90	08/20/90	08/28/90	
Sampling period:	1745-1859	1530-1630	1630-1810	1618-1730	1645-1745	1710-1800		1625-1825	
Description:	work to home	work to home	work to home	work to home	work to home	work to home	work to home	work to home	Avg.
1 PROPANE	7	9	3	4	3	3	19	1	6.0
2 CHLOROMETHANE	465	T	46	T	T	T	T		7.7 **
3 CHLOROETHENE									
4 1,3-BUTADIENE		T			T	T		T	
5 BUTANE	11	21	6	4	49	14	105	14	27.8
6 PENTANE	13	9	5	4	36	18	6	10	12.6
7 ACRYLONITRILE									
8 ISOPRENE		T	T			T	T	3	0.6
9 1,1-DICHLOROETHENE			2	T		9	3	4	3.6
10 DICHLOROMETHANE	T	T		T	T	T	T	T	
11 HEXANE	6	3	5	2	14	11	4	6	6.4
12 TRICHLOROMETHANE							T		
13 1,2-DICHLOROETHANE									
14 1,1,1-TRICHLOROETHANE							T	T	
15 BENZENE	9	9	2	2	9	12	5	6	7.0
16 TETRACHLOROMETHANE	T			T	T	T	T	T	
17 CYCLOHEXANE	T	T	T	T	2	T	T	1	0.3
18 1,2-DICHLOROPROPANE									
19 TRICHLOROETHENE	T				T	T		T	
20 HEPTANE	T	T	T	T	T	T	T	3	0.3
21 1,1,2-TRICHLOROETHANE									
22 TOLUENE	20	4	9	8	17	25	14	21	14.7
23 1,2-DIBROMOETHANE									
24 OCTANE	T		T		T	T	T	1	0.2
25 TETRACHLOROETHENE	T	T	T	6			13	4	3.9

Personal Exposure Pilot Study - Afternoon Commuter Run (1 to 2-hour Samples)

Sample Identification	EP WK1	BK WK3	RB WK4	RC WK5	MS WK6	MS WK7	BK WK8	RB WK9	
	2	2	R1271	4	4	4	1	1	
Date sampled:	06/12/90	06/28/90	07/12/90	07/17/90	08/09/90	08/14/90	08/20/90	08/28/90	
Sampling period:	1745-1859	1530-1630	1630-1810	1618-1730	1645-1745	1710-1800		1625-1825	
Description:	work to home	work to home	work to home	work to home	work to home	work to home	work to home	work to home	Avg.
26 CHLOROBENZENE								T	
27 ETHYLBENZENE	3		1	T	3	5	3	4	2.7
28 M-XYLENE	8		3	3	10	16	7	10	8.2
29 P-XYLENE	10		T			T		T	2.6
TOTAL M,P-XYLENES	9								9.3
30 STYRENE	T		T	T	T	5	T	3	1.1
31 1,1,2,2-TETRACHLOROETHANE			T			T	T	T	
32 O-XYLENE	T		T	T	2	3	2	2	1.2
33 NONANE			T	T	4	6	5	3	3.3
34 1,3,5-TRIMETHYLBENZENE	1						T	T	0.5
35 1,2,4-TRIMETHYLBENZENE	3								3.2
36 DECANE			T				T	2	0.6
37 1,3-DICHLOROBENZENE							T		
38 1,4-DICHLOROBENZENE							T	T	
39 1,2-DICHLOROBENZENE			T			T	19	4	5.7
40 1,2-DIETHYLBENZENE									
41 UNDECANE			T				7	4	3.6
42 1,2,4-TRICHLOROBENZENE			T	T			T	3	0.7
43 NAPHTHALENE									
44 DODECANE									
45 TRIDECANE									
Number of Compounds Detected	22	13	24	19	19	24	30	31	

** This average concentration does NOT include outlier: 465 ug/m3

All concentration units are ug/m3

T= concentration is less than the Method Quantitation Limit (MQL) BUT greater than the Method Detection Limit (MDL)

EP, RB, BK and MS refer to Staff Members; WK = week

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Personal Exposure Pilot Study - Noorhour Walk-Abouts (1-Hour Samples)

Sample Identification:	NOOR WK2 3	NOOR WK3 3	NOOR WK4 1	NOOR WK5 8	NOOR WK6 8	NOOR WK7 8	NOOR WK8 5	NOOR WK9 5	
Date sampled:	06/20/90	06/28/90	07/12/90	07/18/90	08/09/90	08/15/90	08/21/90	08/29/90	
Sampling period:	1200-1300	1200-1300	1210-1310	1200-1300	1200-1300	1200-1300	1230-1330	1200-1300	
Description:	College St. walkabout	College St. walkabout	College St walkabout	College St. walkabout	College St. walkabout	College St. walkabout	College St. walkabout	College St. walkabout	Avg.
1 PROPANE	12	6	13	12	16	10	11	T	9.9
2 CHLOROMETHANE	T	T	6	T	T	T	4		1.4
3 CHLOROETHENE									
4 1,3-BUTADIENE									
5 BUTANE	3	3	5	5	11	4	7	T	4.5
6 PENTANE	7	4	7	6	14	9	6	T	6.5
7 ACRYLONITRILE									
8 ISOPRENE			T			T			
9 1,1-DICHLOROETHENE	T	T		T	5	4			1.7
10 DICHLOROMETHANE									
11 HEXANE	4	2	4	4	9	6	3	T	3.9
12 TRICHLOROMETHANE									
13 1,2-DICHLOROETHANE									
14 1,1,1-TRICHLOROETHANE				T	T	T			
15 BENZENE	5	2	5	4	9	6	4	T	4.4
16 TETRACHLOROMETHANE			T	T	T	T			
17 CYCLOHEXANE	T		T	T	T	T	T		
18 1,2-DICHLOROPROPANE									
19 TRICHLOROETHENE			T		T				
20 HEPTANE	T	T	T	T	T	T	T		
21 1,1,2-TRICHLOROETHANE									
22 TOLUENE	11	6	11	9	16	12	7	T	8.9
23 1,2-DIBROMOETHANE									
24 OCTANE	T	T	T	T	T	T	T		
25 TETRACHLOROETHENE	T		T	T	T				

Table 10

Table 10 ctd.

Personal Exposure Pilot Study - Noonhour Walk-Abouts (1-Hour Samples)

Sample Identification:	NOON WK2 3	NOON WK3 3	NOON WK4 1	NOON WK5 8	NOON WK6 8	NOON WK7 8	NOON WK8 5	NOON WK9 5	
Date sampled:	06/20/90	06/28/90	07/12/90	07/18/90	08/09/90	08/15/90	08/21/90	08/29/90	
Sampling period:	1200-1500	1200-1300	1210-1310	1200-1500	1200-1500	1200-1500	1230-1330	1200-1500	
Description:	College St. walkabout	College St. walkabout	College St walkabout	College St. walkabout	College St. walkabout	College St. walkabout	College St. walkabout	College St. walkabout	Avg.
26 CHLOROBENZENE									
27 ETHYLBENZENE	3	T	2	2	3	2	T		1.7
28 M-XYLENE	7	T	5	5	8	4	4	T	4.1
29 P-XYLENE									
TOTAL M,P-XYLENES									
30 STYRENE	T		T	T	T	T	T		
31 1,1,2,2-TETRACHLOROETHANE	T								
32 O-XYLENE	T		T	T	T		T		0.5
33 NONANE	T		2	T	T		T		0.4
34 1,3,5-TRIMETHYLBENZENE	T								
35 1,2,4-TRIMETHYLBENZENE									
36 DECANE									
37 1,3-DICHLOROBENZENE									
38 1,4-DICHLOROBENZENE	T								
39 1,2-DICHLOROBENZENE	21				T				10.7
40 1,2-DIETHYLBENZENE									
41 UNDECANE									
42 1,2,4-TRICHLOROBENZENE	T								
43 NAPHTHALENE									
44 DODECANE									
45 TRIDECANE									
Number of Compounds Detected	22	12	19	19	21	17	15	7	

All concentration units are ug/m3

T = Concentration is less than the Method Quantitation Limit (MQL) BUT greater than the Method Detection Limit (MDL)

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Table 11

PEPS 1990 VOC Results

Short-Term High Impact Periods
(The Noon-Hour Walk-Abouts and the Afternoon/Morning Commutes)

Number of Samples		Noon (8)	Afternoon (8)	Morning (11)
1	PROPANE	9.9	6.0	15.4
2	CHLOROMETHANE	1.4	7.7	57.1
3	BUTANE	4.5	27.8	21.2
4	PENTANE	6.5	12.6	28.9
5	1,1-DICHLOROETHENE	1.7	3.6	4.3
6	DICHLOROMETHANE	0.0	0.0	1.2
7	HEXANE	3.9	6.4	17.3
8	TRICHLOROMETHANE	0.0	0.0	0.0
9	1,2-DICHLOROETHANE	0.0	0.0	0.0
10	1,1,1-TRICHLOROETHANE	0.0	0.0	1.0
11	BENZENE	4.4	7.0	23.5
12	TETRACHLOROMETHANE	0.0	0.0	10.7
13	TRICHLOROETHENE	0.0	0.0	2.9
14	TOLUENE	8.9	14.7	43.2
15	TETRACHLOROETHENE	0.0	3.9	9.8
16	ETHYLBENZENE	1.7	2.7	5.0
17	TOTAL M,P-XYLENES	4.1	10.8	20.8
18	STYRENE	0.0	1.1	3.3
19	NONANE	0.4	3.3	3.5
20	1,3,5-TRIMETHYLBENZENE	0.0	0.5	0.7
21	DECANE	0.0	0.6	1.4
22	1,2-DICHLOROBENZENE	0.0	5.7	0.7

Concentration units are ug/m3
The above data were acquired from samples exposed for 1 to 2-hours.
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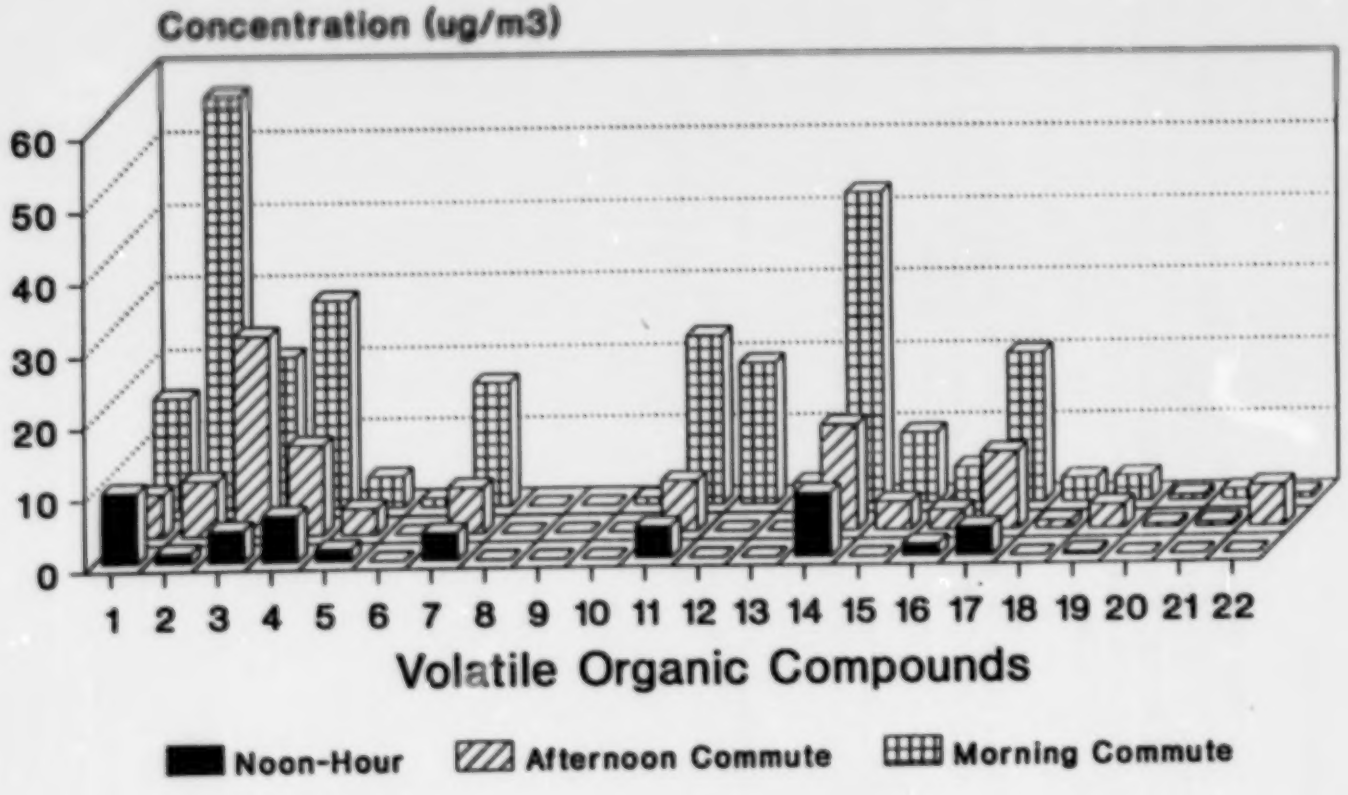
Personal Exposure Pilot Study

Short-term High-impact Periods



1 to 2-hour samples

Figure 8

APPENDIX C
(Other Ministry Work)

Excerpts from:

The 1989 Benzene Study 53
The Toronto Toxics Spring Study 55
The Toronto Toxics Summer Study 61

Laboratory Report : Benzene Study
(Internal Report at ARB, October 1989)
- Prepared by Mr. M.A. Sage -

Summary:

1. Samples were collected while walking along relatively busy traffic arteries in downtown Toronto. It was hoped that the resulting benzene and other volatile organic concentrations would be indicative of exposures representative of those a pedestrian might experience in this area. Twelve such samples were collected during the June - September 1989 period.

2. Samples were also collected, at nose level, while refuelling over 1 to 3 minute periods at gasoline stations. Seven such samples were collected during June - August 1989.

3. For the samples collected while walking downtown, benzene concentrations ranged from 3 to 24 $\mu g/m^3$ with an arithmetic average of 9.4 $\mu g/m^3$.

4. For the gasoline station refuelling samples, the average benzene concentration during the 1 to 3 minute periods was 4324 $\mu g/m^3$, with a range of 674 to 8759 $\mu g/m^3$.

The Volatile Organic Compounds - 1989 Benzene Study

The Walking Samples

	Benz.	Tol.	Etben.	Xyl.	C_3	C_4	C_5
June 7	24	71	13	61	42	100	63
June 14	11	25	4	18	28	17	9
June 23	21	50	8	39	100	39	22
June 28	9	16	2	8	16	16	7
July 25	9	32	4	17	65	24	14
Aug 1	10	12	14	6	17	17	10
Aug 4	9	22	3	14	32	21	11
Aug 8	4	9	1	7	7	5	3
Aug 16	6	8	1	5	11	8	4
Aug 18	3	3	1	2	nd	3	1
Aug 28	3	4	nd	nd	21	15	5
Sept 1	4	10	1	6	24	6	4

The Gas Station Samples

	Benz.	Tol.	Etben.	Xyl.	C_3	C_4	C_5
June 14	1475	1049	54	211	1693	30308	8290
June 14	4572	2755	298	1341	7482	141409	na
June 23	8759	8643	551	2297	8906	247465	61064
June 28	869	1672	77	344	1753	41190	12816
July 17	6543	2254	116	660	2330	55537	24100
Aug 2	674	586	na	96	1912	13865	2440
Aug 8	7378	7256	379	1868	10905	228434	70753

Concentration Units are $\mu g/m^3$
Benz. - Benzene, Tol. - Toluene, Etben. - Ethylbenzene, Xyl. - Total Xylenes
C_3 - Propane, C_4 - Butane, C_5 - Pentane
na - not available, nd - not detected

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Highlights of the Spring Toronto Toxics Study of 1990: Excerpts from the pertinent memorandum.

M E M O R A N D U M

May 28, 1989

To: Maris Lusis, Manager
Atmospheric Research and Special Programmes Section
Air Resources Branch

From: Ronald W. Bell, Co-ordinator
Field Support and Methods Development Group
Monitoring and Instrumentation Development Unit
Atmospheric Research and Special Programmes Section
Air Resources Branch

Subject: The Toronto Toxics Spring Study - 1990

The Environmental Protection Office (EPO) of the Department of Health for the City of Toronto has been charged with conducting an environmental assessment of gaseous toxic compounds in the downtown core area of Toronto. The firm of Rowan, Williams, Davies & Irwin (RWDI) was retained by EPO to undertake this assessment and as a component phase, a special air monitoring programme for metals, volatile and semi-volatile organics commenced on March 27th, 1990. Their field programme consisted of collecting 48 and 24-hour samples at 3 different sites in downtown Toronto; namely at 206 Major Street (a residential neighbourhood), at Queen and Bay Streets (Old City Hall) and at Bloor and Avenue Roads (the ROM - Royal Ontario Museum).

Supplemental to this programme, the Air Resources Branch conducted a high-impact study during these same times at the latter 2 sites. This study consisted of VOC sampling during the morning, noon and afternoon rush-hour periods on March 27th and 28th. In total, 17 field VOC samples were collected and later analyzed by the GC/FID/MS system at ARB. The samples were acquired within the "inhalation zone" (i.e. at nose level) through the use of personal pumps (Gilian) as staff members walked "figure eight" patterns in the vicinity of the RWDI sampler units.

Results and Discussion

.....

.....

.....

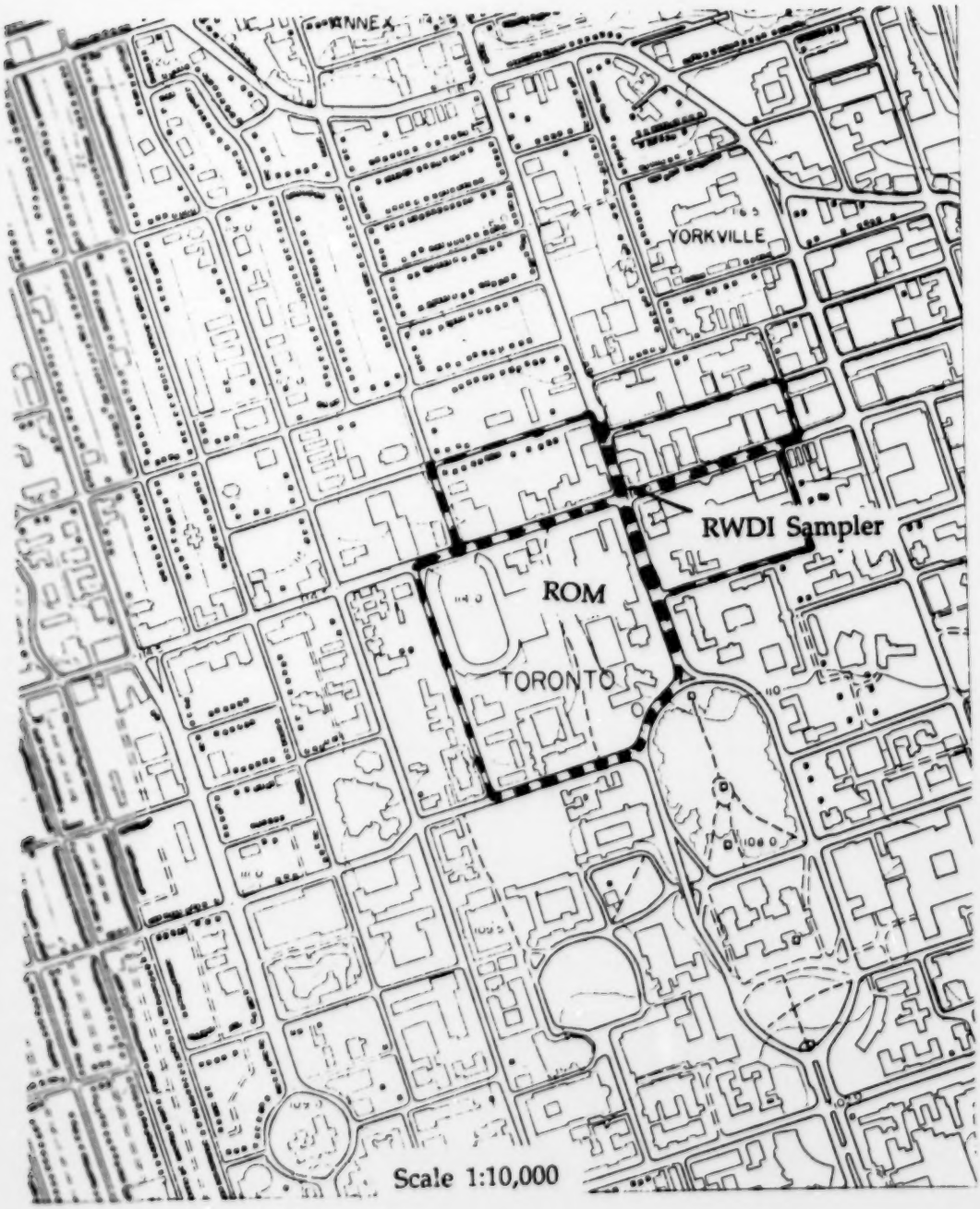
In summary, similar VOC signatures were recorded at both sampling sites. ..... the identity and average concentrations of the selected (targeted) VOCs were very similar ..... and analyses of the duplicate samples yielded almost identical results.

Vehicular emissions were highlighted by the pronounced variability in the alkane and aromatic concentrations. Furthermore, very little variance was noted in the chlorinated aliphatic concentrations throughout the entire study.

From an air quality perspective, none of the applicable Ministry Guidelines, Criteria or Standards were exceeded for any of the detected VOCs and the concentrations were as expected for a heavy industrialized urban airshed.

THE BAY STREET / QUEEN STREET "WALK-ABOUT"

THE AVENUE ROAD / BLOOR STREET "WALK-ABOUT"



Toronto Toxics Study - 1990

	Date collected:	03/27/90										
	Sampling period:	0805-0905		0805-0905		1200-1300		1200-1300		1600-1700		1600-1700
	Location:	City Hall		ROM		City Hall		ROM		City Hall		ROM
			D		D		D		D			D
1	PROPANE	9	35	9	12	14	26	6	10	11	16	40
2	CHLOROMETHANE	4	6	2	6	3	4	3	4	2	2	4
3	CHLOROETHENE											
4	1,3-BUTADIENE											
5	BUTANE	8	20	12	12	11	14	8	12	13	15	28
6	PENTANE	5	18	7	9	7	11	5	6	7	11	18
7	ACRYLONITRILE											
8	1,1-DICHLOROETHENE											
9	DICHLOROMETHANE											2
10	HEXANE	2	8	3	4	3	5	3	3	4	6	8
11	TRICHLOROMETHANE											
12	1,2-DICHLOROETHANE											
13	1,1,1-TRICHLOROETHANE		5	4	5	3	5	2	3	8	3	5
14	BENZENE	5	17	8	10	6	9	4	6	7	12	19
15	TETRACHLOROMETHANE		19	9	8		12				10	12
16	CYCLOHEXANE											
17	1,2-DICHLOROPROPANE											
18	TRICHLOROETHENE											2
19	HEPTANE		3									2
20	1,1,2-TRICHLOROETHANE											
21	TOLUENE	7	24	11	14	8	13	6	8	10	11	27
22	1,2-DIBROMOETHANE											
23	OCTANE											
24	TETRACHLOROETHENE	4	13	10	14	5	8	11	15	6		4
25	CHLOROBENZENE											
26	ETHYLBENZENE		5	2	3				1			5
27	TOTAL XYLENES	5	20	10	12	7	11	5	7	8	5	22
28	STYRENE											
29	1,1,2,2-TETRACHLOROETHANE											
30	NONANE											
31	1,3,5-TRIMETHYLBENZENE		3									2
32	1,2,4-TRIMETHYLBENZENE		5		2		3					4
33	DECANE											
34	1,3-DICHLOROBENZENE											
35	1,4-DICHLOROBENZENE											
36	1,2-DICHLOROBENZENE											
37	1,2-DIETHYLBENZENE											
38	UNDECANE											
39	1,2,4-TRICHLOROBENZENE											
40	NAPHTHALENE											
41	DODECANE											
42	TRIDECANE											

Toronto Toxics Study - 1990

	Date collected:	03/28/90						
	Sampling period:	0810-0910	0810-0910	1200-1300	1600-1700	1600-1700	Averages	
	Location:	City Hall	ROM	ROM	City Hall	ROM	City Hall	ROM
			D					
1	PROPANE	34	32	33	35	38	50	24.0	24.4
2	CHLOROMETHANE	5	3	10	2	4	3	3.7	4.2
3	CHLOROETHENE								
4	1,3-BUTADIENE								
5	BUTANE	45	32	38	31	17	24	19.5	20.5
6	PENTANE	23	22	22	17	15	17	13.2	12.5
7	ACRYLONITRILE								
8	1,1-DICHLOROETHENE								
9	DICHLOROMETHANE	48	35	5				9.2	0.8
10	HEXANE	10	10	11	9	7	8	6.1	6.4
11	TRICHLOROMETHANE								
12	1,2-DICHLOROETHANE	4					3	0.4	0.4
13	1,1,1-TRICHLOROETHANE	7	7	6	11	9	6	5.2	5.3
14	BENZENE	20	19	23	14	13	18	11.9	12.7
15	TETRACHLOROMETHANE	15	13	20	9	10	12	8.7	8.8
16	CYCLOHEXANE								
17	1,2-DICHLOROPROPANE								
18	TRICHLOROETHENE	5	2	5			5	0.7	1.4
19	HEPTANE	3	3	3	3	2	3	1.2	1.4
20	1,1,2-TRICHLOROETHANE								
21	TOLUENE	29	28	33	221	18	25	16.3	43.3
22	1,2-DIBROMOETHANE								
23	OCTANE								
24	TETRACHLOROETHENE	4	4	8	5	4		5.3	8.3
25	CHLOROBENZENE								
26	ETHYLBENZENE	5	5	6	4	4	5	2.1	3.3
27	TOTAL XYLENES	24	23	27	19	16	20	13.2	15.3
28	STYRENE								
29	1,1,2,2-TETRACHLOROETHANE								
30	NONANE								
31	1,3,5-TRIMETHYLBENZENE	3	3	3			2	0.9	0.9
32	1,2,4-TRIMETHYLBENZENE	6	5	6	4	4	5	2.5	2.6
33	DECANE								
34	1,3-DICHLOROBENZENE								
35	1,4-DICHLOROBENZENE								
36	1,2-DICHLOROBENZENE								
37	1,2-DIETHYLBENZENE								
38	UNDECANE								
39	1,2,4-TRICHLOROBENZENE								
40	NAPHTHALENE								
41	DODECANE								
42	TRIDECANE								

Highlights of the Summer Toronto Toxics Study of 1990: Excerpts from the pertinent memorandum.

M E M O R A N D U M

September 4, 1990

TO: Maris Lusis, Manager
ARSP Section
Air Resources Branch
Ministry of the Environment

FROM: Ronald Bell, Co-ordinator
FS & MD Group
ARSP Section, Air Resources Branch
Ministry of the Environment

SUBJECT: The Toronto Toxics Summer Study - 1990

The Environmental Protection Office (EPO) of the Department of Health for the City of Toronto was charged with conducting an environmental assessment of gaseous toxic compounds in the downtown core area of Toronto. This assessment consisted generally of three phases to be executed by the private consultant firm of Rowan, Williams, Davies & Irwin (RWDI).

The first phase required reviewing existing ambient air quality regulations and guidelines for air toxics that exist in other jurisdictions in North America, and reviewing other monitoring surveys for air toxics in the City of Toronto with the objective of developing appropriate protocols for the second phase which was the actual sampling of ambient air. The third phase, involves a risk exposure assessment based on the monitoring results obtained during the second phase.

With respect to the second phase, the Air Resources Branch conducted a VOC study in the downtown core area of Toronto concurrent with the field operations of RWDI during the spring (March) of 1990. The results of this study were presented in a May 28 memorandum addressed to you entitled "The Toronto Toxics Spring Study - 1990". As the next step of the second phase, another ambient monitoring program was undertaken by RWDI on June 12 and 13th .

As mentioned in the May memorandum, RWDI's field program consisted of collecting 48- and 24-hour ambient air samples at three different sites in the downtown Toronto core; namely at 206 Major Street (an urban residential neighbourhood), at Queen and Bay Streets (Old City Hall) and at Bloor and Avenue Roads (the ROM - Royal Ontario Museum) and analyzing these samples for metals, volatile and semi-volatile organic compounds.

Concurrent with the RWDI's June program, the Air Resources Branch conducted its own VOC study at the latter two sites. As with the March study, one-hour VOC samples were acquired during the morning, noon and afternoon

rush-hour periods. In total, 12 ambient air samples were acquired within the inhalation zone through the use of personal pumps as staff members walked figure eight patterns in the vicinity of the RWDI sampler units at the ROM and Old City Hall.

Results and Discussion

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SUMMARY

From analyses of the 12 ambient air VOC samples collected during the June study, vehicular emissions were deemed to be the major source of concern in this downtown area of Toronto. From an air quality perspective, none of the applicable Ministry Guidelines, Criteria or Standards were exceeded for any of the detected VOCs and the concentrations were at expected levels for an urban airshed influenced by vehicular emissions.

Toronto Toxics Study
- 06/12-13/90 (2nd week)

Sample:	AJSA#1	BDC#1	AJSA#2	BDC#2	AJSA#3	BDC#3
Date sampled:	06/12/90	06/12/90	06/12/90	06/12/90	06/12/90	06/12/90
Sampling period:	0820-0920	0826-0926	1200-1300	1202-1302	1600-1700	1555-1655
Location:	Avenue/Bloor	Old City Hall	Avenue/Bloor	Old City Hall	Avenue/Bloor	Old City Hall
1 Propane	27	38	5	35	17	8
2 Chloromethane	T	5	T	T	T	T
3 Chloroethane						
4 1,3-butadiene		T				
5 Butane	3	24	12	11	5	3
6 Acrylonitrile						
7 Pentane	4	25	10	22	6	7
8 Isoprene		T	T	T		
9 1,1-dichloroethene						
10 Dichloromethane		T		T		
11 Hexane	5	18	6	13	4	5
12 Trichloromethane						
13 1,2-dichloroethane						
14 1,1,1-trichloroethane		T	T	T		
15 Benzene	3	14	9	20	5	5
16 Tetrachloromethane		T	T	T	T	T
17 Cyclohexane		T	T	T	T	T
18 1,2-dichloropropane						
19 Trichloroethene		T	T	T	T	T
20 Heptane	T	5	T	4	T	T
21 1,1,2-trichloroethane						
22 Toluene	13	38	15	28	12	9
23 1,2-dibromoethane						
24 Octane	T	T	T	T	T	
25 Tetrachloroethene	T	15	34	14		T
26 Chlorobenzene						
27 Ethylbenzene	3	6	2	6	2	T
28 total m,p-xylenes	9	17	6	15	6	T
29 Styrene		T		T		
30 1,1,2,2-tetrachloroethane						
31 o-xylene	T	5	T	5	T	
32 Nonane	T	T		T		
33 1,3,5-trimethylbenzene	T	3	T	3	T	
34 1,2,4-trimethylbenzene	3	6	T	6	T	
35 1,3-dichlorobenzene						
36 Decane		T		T		
37 1,4-dichlorobenzene	T	T		T		
38 1,2-dichlorobenzene						
39 1,2-diethylbenzene						
40 Undecane		T		T		
41 1,2,4-trichlorobenzene						
42 Naphthalene						
43 Dodecane		T				
44 Tridecane						

Toronto Toxics Study
- 06/12-13/90 (2nd week)

Sample:	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Date sampled:	06/13/90	06/13/90	06/13/90	06/13/90	06/13/90	06/13/90
Sampling period:	0815-0915	0815-0915	1200-1300	1200-1300	1600-1700	1600-1700
Location:	Avenue/Bloor	Old City Hall	Avenue/Bloor	Old City Hall	Avenue/Bloor	Old City Hall
1 Propane	20	10	29	10	28	8
2 Chloromethane	t	t	t	t	t	t
3 Chloroethene						
4 1,3-butadiene						
5 Butane	13	4	15	14	9	13
6 Acrylonitrile						
7 Pentane	13	5	16	25	10	17
8 Isoprene			t	t	t	
9 1,1-dichloroethene						
10 Dichloromethane			t	t		t
11 Hexane	7	2	10	18	4	11
12 Trichloromethane						
13 1,2-dichloroethane						
14 1,1,1-trichloroethane				t		t
15 Benzene	9	5	11	17	8	12
16 Tetrachloromethane	t		t	t	t	t
17 Cyclohexane	t		t	t	t	t
18 1,2-dichloropropane						
19 Trichloroethene	t		t	t	t	t
20 Heptane	t	t	t	5	t	4
21 1,1,2-trichloroethane						
22 Toluene	19	7	27	47	17	26
23 1,2-dibromoethane						
24 Octane	t		3	t	t	t
25 Tetrachloroethene	t	t	t	24		8
26 Chlorobenzene						
27 Ethylbenzene	3	t	5	6	3	5
28 total m,p-xylenes	10	t	15	15	7	14
29 Styrene				t		t
30 1,1,2,2-tetrachloroethane						
31 o-xylene	t	t	t	5	t	5
32 Nonane			t	t	t	
33 1,3,5-trimethylbenzene	2	t	2	6	2	4
34 1,2,4-trimethylbenzene	4	t	4	7	t	8
35 1,3-dichlorobenzene				t	t	t
36 Decane						
37 1,4-dichlorobenzene	t		t			
38 1,2-dichlorobenzene						
39 1,2-diethylbenzene						
40 Undecane			t	t	t	t
41 1,2,4-trichlorobenzene						
42 Naphthalene						t
43 Dodecane						t
44 Tridecane						